Wind River

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FIRE CONTROL NOTES

A PERIODICAL DEVOTED TO THE TECHNIQUE OF FOREST FIRE CONTROL

FOREST SERVICE • U. S. DEPARTMENT OF AGRICULTURE

FORESTRY cannot restore the American heritage of natural resources if the appalling wastage by fire continues. This publication will serve as a channel through which creative developments in management and techniques may be communicated to and from every worker in the field of forest fire control.

Volume 8 Number 1

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A Quarterly Periodical Devoted to the

TECHNIQUE OF FOREST FIRE CONTROL

The value of this publication will be determined by what Federal, State, and other public agencies, and private companies and individuals contribute out of their experience and research. The types of articles and notes that will be published will deal with fire research or fire control management: Theory, relationships, prevention, equipment, detection, communication, transportation, cooperation, planning, organization, training, fire-fighting, methods of reporting, and statistical systems. Space limitations require that articles be kept as brief as the nature of the subject matter will permit.

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Contents

RESULTS FROM MECHANICAL FIRE LINE CONSTRUCTION

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Paralleling the coast from North Carolina to Texas is an area of approximately 250,000 square miles, or 160,000,000 acres, grading from flat coastal plain to rolling uplands. The greater part of this area is forest land, about 62,000,000 acres in the longleaf-slash pine type, and most of the remainder a mixture of shortleaf-loblolly pine and hardwoods.

Following the cutting of the heavy original timber stands, the shortleaf, loblolly, and slash pines tended to prolific reproduction, limited by the frequency of wild fires. The longleaf pine, which has infrequent seed years, came back in fair but understocked stands where team logging left small or defective but seed producing trees. Where clear-cutting and railroad skidders, tearing down all but an occasional sapling, were used and followed by intense logging debris fires, there are today large areas with only scattered clumps of reproduction.

With fire protection, the potential timber capacity of this entire forest region is tremendous. Because of the long growing season, favorable climate and soils, both pines and hardwoods will grow with almost unbelievable rapidity. On large blocks of the better sites protected from fire annual growths of 400 to 600 board feet per acre per year are common; 150 to 200 board feet per acre is common to the poorer sites. Stands of 20,000 board feet per acre are frequent on land that someone tried to farm 40 years ago.

Also, accessibility and unsurpassed market conditions combine to create a forester's dream. Heavy demands for fence posts, pulpwood, poles, piling, and sawlogs give opportunity to practice a succession of good silvicultural thinnings and cuttings, each at a profit. All products enjoy exceptionally high stumpage values.

The Fire Problem in the Southeast

The one thing standing in the way is uncontrolled fire.

From the days of the earliest settlers, light burning, annual or biannual, has developed into accepted custom and tradition; in some sections it reached the dignity of a civic duty. In the longleaf areas the wire, sedge, and other grasses with their high, luxuriant growth generate a real conflict between the stockman and the tree man. Large numbers of cattle and sheep graze the piney woods. By tradition, unfenced lands are "open range" for any stock owner. A person can

easily make a fair living by running a herd without cost on the other fellow's land. The grasses make pretty fair forage in the summer and cure after frost into a dense mat of natural hay on which the stock winters. The conflict comes in the early spring when stock needs fresh grass. The new sprouts are buried under the dead growth which will accumulate from year to year. If a fire removes this cover, a luxuriant new growth of grasses is available for grazing in a matter of days.

Years of steady work by many agencies toward overcoming this hereditary practice of burning has won the majority to the side of protection, but there remains among the rural residents a large aggregate of citizens who still feel the urge to draw their matches at the drop of a leaf. The problem of the land managers and fire control agencies is to squeeze the area that can be burned by these often well-meaning fire setters.

The deep mat of dead grass, augmented by needles, leaves, and shrubs, continuous over great stretches of woods, sets up a high fire potential. Such fuel is flash, burns explosively, and produces hot, high flames that often go into the crowns of the trees. The fires spread with extreme rapidity. Before the high gusty winds, common to the region in early spring, heads of fires frequently run in the speed range of 2 to 3 miles per hour.

State foresters and individual owners tried to interfere with the spread of these fires, but their meager forces with hand tools often could do little more than keep them from crossing roads, streams, or like barriers. Various fire-control men reached the conclusion that a reasonably good job of suppression in the flatwoods could not be done by hand. They were handicapped by both lack of funds and lack of equipment, but they did develop tankers and made a start on heavy plows.

CCC Hand Control

The picture changed with the advent of the CCC program in which this section enjoyed a large share. Camps on State, private, and national forest lands placed around 75,000 young men in these woods. They were organized in crews with their foremen, supplied with transportation and plenty of hand tools, were well trained, and always available in numbers for a quick getaway to a fire. At the height of CCC the South was in a favorable position to control fires efficiently with manpower, if men and hand tools could do the job.

The CCC boys did a man's job, but it became more and more evident that their efforts were out of proportion to the results. In the easier fire weather they did pretty well. During bad fire weather, with rakes, flaps, and back-pumps, they fought valiantly, frequently to exhaustion, only to have fires get away from them. There were such instances as a fire being attacked when small, receiving a plentiful concentration of fresh crews, but still, a few hours later, reaching 10,000 acres.

Foremen shook their heads over the brutal work they were requiring of their men. State foresters, rangers, and supervisors who were observant became convinced that this was the wrong answer. The man with the match was still master of the suppression forces.

Building of Mechanical Units

As time went on the future prospects of hand-tool suppression looked even darker. Despite the handicaps and limitations, the aggregate of control efforts had resulted in a marked reduction in the frequency with which many areas were burned—large areas were protected with but small percentages of burned acreage over a number of years. With this protection, suppression became more difficult year by year as the amount of fuel on the ground increased. Seedlings lived and grew into dense stands of advanced reproduction, but thickets of bushes and brushy growth also thrived. On the better growing sites, unburned for 10 or 12 years, the fuel and brush accumulations became so heavy as to make hand tools entirely too slow and ineffective. Field men also realized that CCC must sooner or later end and fire crews would have to come from slowly gathered farmers, loggers, or distant town labor.

In those days they began moving toward mechanical fire-line building. The only fire plows in sight were a pusher type developed by the Arkansas State Forester and those being built by Mathis and Rome. Powered by 35- and 50-horsepower crawler-type tractors, they built a good line about 5 feet wide through the heavy palmetto-gallberry sod cover. As more and more of these units were placed in operation, their value was quickly established. When they could be gotten to a fire, they built a line at a rate of about 1 mile per hour, a line which would hold on the flanks and which could be backfired to stop a head fire. They made suppression surer and faster.

The weakness of these heavy units was the difficulty and long elapsed time required to get them to a fire. The four-disc-type plow weighed 3,600 pounds; the two-disc type about 2,400 pounds. The smallest tractor that could successfully pull the two-disc plow weighed 12,000 pounds. Transporting these units to a fire required a heavy truck-trailer which carried the tractor and towed the plow. On ordinary roads the loaded outfit traveled 10 to 12 miles per hour, with travel rate becoming slower after turning into back-country or woods roads. The point beyond which the heavy truck could not travel was often reached while still far from the fire, necessitating "walking in" the tractor for two or more miles. These units were quite helpful, but the limitation of slow, ponderous travel made their time of arrival disappointingly late. In the fast-burning fuel types, fires often reached class D size before a plow could be put to work. The plows stopped some fires at a reasonable size, but in the main their role was to help keep already large fires from getting much larger.

Brief study of the situation pointed out the necessity for a line-building unit that could be delivered on the fire at a speed which would appreciably reduce the critical and all-controlling elapsed time between start of fire and effective attack. We knew speed of travel would have to be bought through the sacrifice of some of the valuable characteristics of the heavy units. The hope was that a unit could be developed which would build the least line one could get by on, translating the weight saving into travel speed—a unit that could control a fire in medium fire weather, and in bad fire weather could get on a fire while it was still small and hold it until a heavy plow could get there.

The controlling specification was a tractor-plow unit that could be transported on a 1½-ton stake body truck. In the spring of 1944, a Clarkair tractor weighing 3,175 pounds was obtained for experimental purposes. The engineers and mechanics went to work and created a light plow. A series of field trials and alterations resulted in the plow known as the Rangers Pal, weighing 465 pounds. The total 3,600-pound unit would not seriously overload a 1½-ton truck and could travel at 50 miles per hour on good roads.

The small Pal plow, used where there are no stones, is 7 feet long and 28 inches wide. Mounted on a central beam front to rear are: A three-height tractor hitch; an 18-inch rolling coulter; a middle buster plow point; two 20-inch discs; a worm gear depth adjusting device; two short wings to roll back the overcast; and two wheels with 4.00 x 8 tires which ride within the plowed furrow. This plow builds a furrow 28 inches wide at the bottom. With side slopes and overcast of dirt, the total width of mineral soil line is 48 to 54 inches, depending upon the nature of the soil and the depth to which the plow is set to cut. In fire line plowing it works best at a speed of 1½ to 2 miles an hour on level ground, but will plow up to 3 miles per hour.

In the summer of 1944 the HG Cletrac became available. Its wider tread, greater clearance, and less weight (3,000 pounds) made it more desirable for plow use than the Clarkair. Seventeen of these HG tractors were purchased; our equipment shops built 15 Pal plows and 2 middle buster plows. These last were for use on stony ground found in the Talladega Mountains in Alabama. Stake trucks were rigged for fast loading and unloading. These units were distributed to our most critical fire districts and used on the season's fires. To the extent that sets were available, these units were equipped with radio. The suppression results from these plows far surpassed our expectations. They hit fires very quickly and built line with a speed that prevented build-up and demonstrated that they could handle a fire on a class 5 day.

In 1945, 12 more of these units were constructed and radios installed on all but a few of them. Radio is vital toward getting the most out of a unit. It enables the ranger during bad fire weather to distribute his plows at strategic locations, start them off immediately upon discovery of a smoke, and give the crews directions while traveling. When the units are finished with one fire, they are dispatched to another without loss of time.

With the great variations of soil and ground cover there can, of course, be no one all-purpose weapon. It is presently estimated that our conditions call for three distinct sizes of units: The light Pal plow for use in the grassy, more open longleaf type; an equal weight unit with a middle buster type plow for the hill country up to 30 percent slope; and the heavy two-disc Mathis type plow in the luxuriant and dense cover found in Florida and the Carolina coastal areas. Middle weight plow units have been built for use in the heavy but less dense cover found in the inland loblolly type. These middle weight plows follow the same general design as the Pal plow but weigh around 900 pounds, are raised and lowered by a hydraulic jack, and are pulled by a T–6 tractor weighing 6,750 pounds. For these, special carriers were designed, consisting of a Hi-Low semitrailer with a 1½-ton truck for a prime mover. These carriers will make 40 miles per hour on good

roads. To speed up travel and increase their range, Hi-Low semi-trailers have been built to carry both the heavy Mathis plow and its tractor. The prime movers are 2½-ton 6×6 (Army type) trucks for the heavy going, and 2-ton 4×4 (Army type) trucks elsewhere.

Method of Use of Mechanical Units

The size of the crew with each plow unit is varied with type of country and existing class of fire weather. A typical crew is composed of a lead man, tractor driver, backfiring torchman, and follow-up man with back-pack pump and flap. Such a crew has successfully suppressed 6 successive fires in one class 5 day. One famed crew on a Mississippi district handled 72 fires last spring by themselves. If it appears that there will be much of a mop-up job, a hand-tool crew is dispatched to take over that part of the work and release the plow crew for another fire.

Attack by a single plow unit is an undesirable tactic. Because there were not enough units available for the job at hand it was necessary on all but a few of the fires studied. (Seven more Pal units are under construction and some doubling up can be practiced next spring.) On a number of occasions ranger districts had more going fires than plows. Attack was delayed on too many fires. They got pretty big before plows could be disengaged from other fires. On days of lower fire occurrence, two plows attacked some fires and there were a few opportunities to use three. The rapidity of suppression under such attacks was so striking as to indicate that the desirable action and the key to obtaining a reasonably small percent of burned acreage is to dispatch two plows to many of the class 3 day and to all class 4 day fires; three plows on all class 5 days or to any incendiary fire with numerous sets on any class fire day. The secret of success is the elimination of each fire in the shortest possible time. Then, all units are available for assignment to other fires. Another factor makes time important. On bad windy days heads run rapidly and produce a long cigar-shaped burn. Winds frequently make a 90° shift. The longer the time before both sides are controlled, the greater the risk that wind shift will turn one or the other flank into a broad front head fire.

A plow unit requires an appreciable investment of funds. The national forests in Region 8 have within their protection boundaries approximately 10,000,000 acres where tractor plows will work to advantage. State foresters and large lumber and pulp companies have as their long-time objective, as funds and facilities become available, adequate protection of an estimated 100,000,000 acres of potential "plow country." The State organizations have been adding tractor plows to their forces as their funds will permit and some units have been acquired by industrial landowners. Two fundamental protection questions to be resolved are: "What method of fire line building gives the best combination of effectiveness and economy?" and, if the advantage is with the plows, "To what extent will investments in mechanized units pay off?"

Comparison of Results

A preliminary study was made this summer to assess and compare the results so far obtained. We wanted to know whether our present

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investment in plow units had been good business and, if so, to obtain indications as to the extent we are justified in making further investments and to give guidance to other fire protection agencies who are considering trying or expanding mechanical fire line building.

An analysis was made of 315 fire reports for the calendar year 1940 from the Catahoula, Evangeline, Kisatchie, and Vernon units in Louisiana, and for the year 1941 from the Leaf River, Chickasawhay, and Biloxi Ranger Districts in Mississippi.

The area protected within these particular ranger districts is 1,132,926 acres. On and around them is found the highest concentration of man-caused fires in the United States. This group of ranger districts enjoys the dubious honor of a 5-year average of 752 man-caused fires per year. Besides the bare figures of high occurrence, other factors contributed to the severity under which the plow units were tested. Most of the fires are incendiary, planned by men who know the areas intimately, choose the time of day, weather, and burning conditions, and place numbers of sets, all calculated to give fire every possible advantage. The fire setters make it a little rougher by crowding large numbers of fires into particular days. There were 2 separate days last spring when the Chickasawhay District had 26 fires, and 4 days with concentrations of 15 to 20 fires.

In the years 1940 and 1941 the 7 districts had no fire plows but conditions were about as advantageous as could be for good hand-tool results. The areas studied then had 8 CCC camps, or about 1,200 active young men organized in crews with their foremen, transportation, and some light tankers. The boys were well trained, crews could be gotten together and started quickly, and on bad fire days were often placed out on standby. Fires were usually attacked with a truck load or more of men with followup available. The results obtained by these CCC crews must be considered as quite good for hand-tool suppression, and far superior to what could be expected from equal sized crews gathered from farms, sawmills, or towns.

For comparison, the actions on 526 plow-fought fires on these same districts in the spring season of 1946 were analyzed. There were 6 heavy Mathis type plows and 11 Ranger Pal plows on these districts during the early part of the fire season, and 6 more Pal units were added during the course of the fire season.

To prevent distortion, we threw out of the study those outside fires which were simply cut off near the boundary, class 2 day fires because they were so inoffensive as to give no test to suppression methods, and fires under 5 acres in final size. A fire in the flatwoods during strong burning weather that is suppressed with hand tools at less than 5 acres usually represents special circumstances, such as being held by roads, streams, or fields.

Table 1 shows the comparative results from hand-tool crews and tractor-plow crews under like burning conditions.

Table 2 gives the percent of fires which became class D size (100 to 300 acres) and class E size (over 300 acres) under each method of suppression. The test of a method is rather well measured by its results under bad conditions. Historically, this region has lost the big part of its burned acreage from those few fires that were not well held; fires that on severe fire days were too much for the available manpower.

Table 3 shows the complete cost of each of the three sizes of plow units. Because much of our equipment was Army surplus and some old CCC surplus, these costs are considerably below the expenditure probably required to obtain similar items under present market conditions.

TABLE 1.—*Size of fires, and work required to control them by hand tools and by plows*

Class fire day	Average size of fires						Average time on line building		Average maximum men per fire (includes mop-up)		Average length of held line	
	Hand-tool control			Plow control								
	Beginning of attack	Final	Increase	Beginning of attack	Final	Increase	Hand tools	Plows	Hand tools	Plows	Hand tools	Plows
	Acres	*Acres*	*Percent*	*Acres*	*Acres*	*Percent*	*Man-hrs.*	*Man-hrs.*	*Number*	*Number*	*Chains*	*Chains*
3	23.0	57.2	149	14.4	28.7	101	20.15	5.37	18.0	5.6	75.2	57.1
4	45.6	93.7	105	17.7	36.5	112	24.99	5.86	22.6	6.4	83.2	67.7
5	49.8	422.2	748	22.1	67.9	207	52.51	10.40	30.3	8.2	160.3	83.0

TABLE 2.—*Percent of total fires reaching class D and class E size, by hand-tool and plow suppression*

Class fire day	Class D size (100 to 300 acres)		Class E size (over 300 acres)		Total over 100 acres	
	Hand tools	Plows	Hand tools	Plows	Hand tools	Plows
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
3	18.6	2.6	2.0	0.0	20.6	2.6
4	11.2	5.1	4.0	0.4	15.2	5.5
5	22.5	11.2	16.9	2.8	39.4	14.0

TABLE 3.—*Cost of plow units*

Part	Heavy plow unit		Medium weight unit		Light plow unit	
Truck	(2½-ton, 6 x 6)	$2,000	(2-ton, 4 x 4)	$1,800	(1½-ton)	$800
Hi-Low trailer		800		800		
Tractor	(D-4)	4,000	(T-6)	2,400	(HG Cletrac)	1,400
Plow		750		700		275
Radio		450		450		450
Total		8,000		6,150		2,925

The 526 (analyzed) plow-fought fires, if suppressed by hand, (figuring costs upon the manpower required to suppress with hand tools the 1940 and 1941 fires and the wage rates prevailing here last spring) would have cost an average of about $57 each for suppression labor and crew bosses, or around $30,000. Although our cost accounting system does not provide for exact identification of costs by individual fires, by totaling the manpower and equipment time from the fire reports and applying current wage rates and our standard costs of

equipment, operation, and depreciation, it was found that the cost of suppressing these 526 fires was approximately $6,800, an average of about $13 per fire. Thus, there is an indicated saving of $23,200 or $44 per fire in suppression costs.

Table 1 demonstrates the reduction in acres burned per fire, under the different fire weather conditions, when fought by tractor plows instead of hand tools. The most significant figure is the reduction in the size of area burned under plow control on the worst fire days. What the losses from fire damage to reproduction and timber would have been on the acres which probably would have burned except for the plows is too speculative to reduce to reliable figures. The study did tell us the 315 hand-tool suppressed fires burned 47,523 acres, whereas 526 plow-fought fires burned 18,015 acres. Hand-tool controlled fires averaged 150.8 acres per fire as compared with 34.2 acres per plowed fire. Further studies may show that these averages will vary both ways from year to year or according to the types of country, but the spread is so significant as to assume the position of major importance.

Conclusions

Reduction in the amount of damage from fire is the primary objective of a fire control organization. Whatever the average damage per acre resulting from wildfire in any given stand, it seems axiomatic that a mechanical method of suppression which gives promise of saving well over two-thirds of the former losses, besides the reduced cost of operation, will have paid its way after a very few fires.

It is also our judgment that mechanical suppression will prove to be a firm base for far better fire prevention. In a section of the country where so many people lean toward promiscuous burning, they will give really serious consideration to the teachings of foresters only after it is well demonstrated to them by stopping fires with dispatch that the foresters mean business. When they see us, the preachers of fire prevention, fighting fire ineptly, permitting what they judge to be unnecessarily large burns, they question the real sincerity of our talk. Where suppression action has not been too good, we even encounter the idea among the residents that under all the talk, the fire organizations really want quite a bit of fire in order to keep their jobs alive.

From the true incendiary, the fellow who sets out to burn a large piece of the other man's lands to save himself from buying spring feed for his stock, we expect a considerable increase, for a while, in the number of fires. The stockman usually has in his mind some certain size burn as an objective. He can often get such a burn from one fire fought by hand tools. If a tractor plow suppresses his fire at small size, he will repeat his fire settings again and again on other days, trying to get the size burn he originally wanted. This will be annoying at the time, but those actions tend to segregate and identify these burners. They follow predictable patterns of action until it becomes more and more probable that properly placed guards will be able to apprehend them in the act. With some court convictions and the increased risk of being caught, we believe that fast suppression will gradually discourage this worst source of fires.

Another major source of fires on the national forests of this Region has been the "job fire." When money was short, it was very common to have a scattering of fires set so the boys in a community could get some work putting them out. In ground cover where large crews are required to keep fires from reaching critical size, these "gravy train" set-ups have the ranger in a bad defensive position. With fast mechanical units employing only a few reliable men, each unit easily more effective than 25 good men, the "job fire" people find that they have lost their power, the ranger is independent of them, and they are not hired. They soon discover that the cause of their temptation is gone.

Another important gain from mechanical suppression not brought out by statistics is the reduction of the "fatigue factor." The physical demands placed on hand crews by fast-spreading hot fires can be so great that men frequently play out before completing suppression of one fire, and they are seldom in condition to be assigned to a new fire without a long rest. Plow suppression does not overfatigue the crew, and the men are able to act energetically on successive fires all day long if needed.

The big question is, Does mechanical fire line construction pay? We conclude from the data at hand that an organization with any appreciable area of "plow country" to protect cannot justify the large suppression bills and heavier damage losses that occur without such equipment.

How far can one go in investing in equipment? In the first place, it has required the current condition of the lumber market and the price lists to bring home not only to the general public but to a lot of people in the business that we have become a chronic "have not enough" lumber nation. Our timber stands and vulnerable reproduction have attained a monetary value and a place of economic importance that jolts us all. Fire damage from now on will have to be calculated a lot higher than when it was thought "there is plenty more."

There can be no simple formula applicable to different areas. There are some good guides.

Depending upon the local rate of fire spread, there needs to be an outfit within a travel time permitting attack before the fire gets to critical size. Critical size would be governed by the values at stake where the fire is burning and the threatened values where the fire is heading.

The frequency of fires, the number that will have to be fought per year in a given area, is a part of the equation.

In the area studied, with one fire per year for each 1,500 acres, our speculative calculations indicate that we can afford a small unit for each 30,000 acres of our reasonably well stocked stands. That would mean an initial investment of about \$0.10 per acre. It costs around \$12 per acre to plant trees on denuded land. Our pine stands have an annual growth value of \$1.50 to \$5 per acre with growing stock on the ground which will bring from \$20 to \$75 per acre in the lumber market. The investment in mechanical equipment for fire line construction looks like pretty cheap fire insurance.

HIGH LIGHTS FROM RESULTS OF HELICOPTER TESTS

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Operation

Since October 1945, the testing of performance of Army Air Force helicopters in mountainous areas has been conducted on the Angeles and San Bernardino National Forests, Region 5, in cooperation with the 62d AAF Base Unit (Air Rescue Service), March Field, Calif. The first ships furnished the test project were the Sikorsky R-6 model.

Helicopter R 5–A on approach for landing on Cajon Ridge, with nose up to reduce forward speed. Altitude, 3,800 feet above sea level.

This small two-place craft was soon found to be inadequate in pay-load capacity and altitude range for Forest Service work. Tests on the Sikorsky R 5–A equipped with standard rotor blades were initiated at March Field in April 1946. Considerable was learned about helicopter operation in mountainous areas with this ship. But the R 5–A also lacked the ability to carry the necessary pay load in spot landings and take-offs at elevations over 3,000 feet with summer temperatures.

In July 1946, a set of new high lift blades was furnished the project by Sikorsky. Although the performance data given below are primarily for the R 5–A with these high lift blades, certain data for the same helicopter with standard blades are shown for comparative purposes. All data would apply to the R 5–D or S–51 models when equipped with the same blades.

Effect of Temperature

All aircraft performance specifications and all performance data included in this article are for N. A. C. A. Standard Air. Altitudes under N. A. C. A. Standard Air conditions are called density altitudes.

Table 1 may be used for converting measured elevations or altitudes to density altitudes (N. A. C. A. Standard Air) or vice versa. Since no correction for variation in barometric pressure at sea level is made in this table, precision is to the nearest 150 feet. Example: A landing spot has a measured elevation of 7,000 feet as determined from the topographic map. Weather records show that during the summer, temperatures at this landing spot may often reach 90° F. From table 1 the approximate density altitude at this landing spot would be 10,700 feet at 90° F. The helicopter would perform under these conditions as though it were at an altitude of 10,700 feet. Interpolation of values given in the table may be necessary in many cases.

TABLE 1.—*Approximate density altitude (N. A. C. A. Standard Air)*[1]

Measured elevation above sea level (feet)	Density altitude when air temperature at actual elevation is—					
	30° F.	45° F.	60° F.	75° F.	90° F.	105° F.
	Feet	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*
1,000	−500	400	1,200	2,200	3,200	4,100
2,000	700	1,500	2,400	3,500	4,400	5,300
3,000	1,900	2,900	3,700	4,700	5,700	6,600
4,000	3,200	4,100	5,000	6,000	6,900	7,800
5,000	4,500	5,400	6,300	7,300	8,200	9,000
6,000	5,700	6,600	7,500	8,500	9,400	10,300
7,000	7,000	7,800	8,800	9,800	10,700	11,500
8,000	8,300	9,100	10,000	11,000	12,000	12,800

[1] Assuming a barometric pressure at sea level of 29.92″ Hg.

Specifications and Performance

The specifications and performance of the Sikorsky R–5 (S–51) helicopter are given in the following tabulation. Manufacturer's data were obtained from tests performed for C. A. A. All altitudes given are density altitudes under N. A. C. A. Standard Air conditions.

Specifications

Weight:
- Gross, Model R 5–A — 4,900 pounds
- Model S–51 — 4,985 pounds
- Empty, Model R 5–A with standard equipment — 3,760 pounds
- Empty, Model R 5–A or S–51 stripped of nonessential covering and auxiliary equipment — 3,500 pounds

Seating capacity:
- R 5–A — 1 passenger and 1 pilot.
- R 5-D and S–51 — 3 passengers and 1 pilot.

Fuel capacity — 100 gallons.

Oil capacity — 8 gallons.

Engine: Pratt-Whitney Wasp Junior R–985–AN–5.
- Normal rating — 450 b. hp. at 2,300 r. p. m. at sea level.
- Take-off rating — 450 b. hp. at 2,300 r. p. m. at 2,300 feet altitude.
- Fuel — Grade 91 octane.
- Oil — Grade SAE 60 Summer, SAE 50 Winter.

Dimensions:
- Length, over-all (blades extended) — 58′ 0½″
- Length, over-all (blades removed) — 44′ 11½″
- Height, over-all — 12′ 11″
- Main rotor diameter — 48′ 0″

Specifications—Continued

Dimensions—Continued

Tail rotor diameter	8′ 5″
Alighting gear tread	12′ 0″
Cabin width, pilot's (S–51)	4′ 5″
Cabin width, passengers' (S–51)	5′ 2″
Cabin height, floor to ceiling	4′ 5½″

Performance

	High lift blades	*Standard blades*
Gross weight, 4,900 pounds:		
Maximum speed placarded by C. A. A. (3,900 ft.)	103 m. p. h	103 m. p. h.
Cruising speed at 65 percent b. hp. at sea level	80 m. p. h	80 m. p. h.
Minimum flying speed (up to hovering ceiling)	0 m. p. h	0 m. p. h.
Fuel consumption (cruising), approx	28 gal./hr	28 gal./hr.
Gross weight, 4,985 pounds:		
Maximum rate of climb at sea level	1,370 ft./min	1,230 ft./min.
Hovering ceiling without ground effect	6,200 ft	3,200 ft.
Hovering ceiling with ground effect	8,000 ft	6,800 ft.
Absolute ceiling	17,250 ft	14,900 ft.
Gross weight, 5,180 pounds: Ceiling	16,200 ft	11,000 ft.

The data shown in tables 2 and 3 were obtained from actual tests on the Angeles and San Bernardino National Forests. Successful landings and take-offs were made in mountain terrain with the loads shown at the altitude indicated, except that no tests were run at density altitudes greater than 9,300 ft.

The net pay load shown was computed as the difference between the gross weight of the machine and the weight of the stripped machine when serviced for a 125-mile operating range as shown in table 2.

TABLE 2.—*Maximum gross weight and net pay load for spot landing and take-off at various density altitudes* [1]

Dimensions—Continued Density altitude, N. A. C. A. Standard Air (feet)	Gross weight		Net paid load	
	High lift blades	Standard blades	High lift blades	Standard blades
	Pounds	*Pounds*	*Pounds*	*Pounds*
1,000	5, 600+	5, 460	1, 500	1, 360
2,000	5, 600+	5, 300	1, 500	1, 200
3,000	5, 520	5, 140	1, 420	1, 040
4,000	5, 380	4, 980	1, 280	880
5,000	5, 250	4, 820	1, 150	720
6,000	5, 110	4, 660	1, 010	560
7,000	4, 970	4, 510	870	410
8,000	4, 830	4, 340	730	240
9,000	4, 700	4, 190	600	90
10,000	4, 560		460	
11,000	4, 420		320	
12,000	4, 280		180	

[1] Wind velocity at 20 feet above landing spot, 0 to 5 m. p. h.; full throttle; engine speed, 2,300 r. p. m., except 2,400 r. p. m. while breaking ground and approaching for landing. Minimum clearance while hovering at 2,300 r. p. m. and full throttle, 3 feet.

It should be noted that while the helicopter is capable of operating successfully at a gross weight considerably in excess of 4,900 pounds, this is forbidden in actual operations as C. A. A. does not permit loads in excess of the designed gross.

For practical purposes, therefore, it is necessary to reduce the fuel load in order to carry the maximum pay load and still keep within the designed gross weight. This may be accomplished as follows:

	Pounds
Weight, empty (stripped)	3,500
Pilot (1)	170
Residual fuel and oil	30
Oil (6.7 gallons)	50
Fuel (58.3 gallons for 1 hour 33 minutes, including 15 gallons reserve)—sufficient for 125-mile range	350
Operating weight (no pay load)	4,100
Pay load	800
Gross weight	4,900

It may be seen then from table 2, that the maximum density altitude to which the maximum pay load may be carried is 7,500 feet for the high lift blades, and 4,500 feet for the standard blades.

While the machine may not be used to carry the loads it is capable of handling at the lower altitudes, it is obvious that the load reduction will result in progressively increased performance as the altitude is decreased. This is shown in terms of rate of climb in table 3.

TABLE 3.—*Rate of climb of helicopter with high lift blades*[1]

Density altitude (feet)	Rate of climb	Manifold pressure	Density altitude (feet)	Rate of climb	Manifold pressure
	Feet per minute	*Inches Hg*		*Feet per minute*	*Inches Hg*
3,000	1,210	35	8,000	600	30½
4,000	1,040	35	9,000	520	29
5,000	900	34	10,000	440	28
6,000	800	33	11,000	350	27
7,000	700	31½	12,000	270	26

[1] Gross weight, 4,900 pounds; engine, 2,300 r. p. m.; air speed, 60 m. p. h. Best rate of climb speed is approximately 50 m. p. h.

Hovering

Hovering is one of the most important types of operation. Theoretically, a helicopter can climb vertically to its hovering ceiling (without ground effect). This is not practical, however, as it places undue strain on ship and engine, and pilots find it easier to climb with forward speed. Hovering between 30 and 300 feet above the ground is considered hazardous, since in case of engine failure, a successful autorotation landing may not be made. The hovering ceiling (without ground effect) is the maximum density altitude at which the helicopter can maintain altitude with zero air speed.

When hovering close to the ground (12 feet wheel clearance for R–5 or S–51), an air cushion is built up between the rotor and the ground. This cushion provides additional lift and the operation is called hovering *with* ground effect. The hovering ceiling with ground effect is slightly higher than the maximum density altitude at which spot landing and take-off with a given gross weight can be made with normal power settings.

Vertical descents are not normally made except within the ground cushion.

Landing and Take-Off

Normal landing and take-off paths for the helicopter are similar to those for a light airplane, except no run on the ground is required for the helicopter and the helicopter climbs and descends more steeply.

R 5–A at moment of final hovering before landing on Cajon Ridge, Calif.

Specifications for Spot Landing Areas for R–5 (S–51) Helicopter With High Lift Blades

1. Landing-area requirements for spot landings and take-offs of the helicopter are the same for all elevations. Terrain should slope gently away from the landing spot for about 500 feet. Landing areas located on ridge-top knolls are most desirable. The ridge-top location is preferred to one in a canyon because normally less clearing is required, and in take-offs, flying speed may be more quickly gained by losing altitude. Also, ridge-top landing areas require little maintenance and special drainage.

2. Landing areas in accordance with these specifications are considered safe for normal spot landings and take-offs, but if the area is to be used for autorotation landing the obstacle height should be lowered 25 feet from that shown in the tabulation below.

3. The minimum landing spot should be 200 feet in diameter, level and graded.

4. Clearing for landing approach and take-off paths should be located so helicopters can land and take off into the wind. Satisfactory cross-wind landings and take-offs are difficult when wind is gusty.

Distance from center of landing spot	Maximum permissible height above landing spot of obstacles in take-off and landing approach paths
Feet	*Feet*
100	0
200	3
300	14
400	20
500	47
600	63
700	79

Although exceptionally large and high obstacles between 700 and 2,000 feet from the landing spot and along the take-off or landing approach path are undesirable, clearing beyond 700 feet is unnecessary since the helicopter can take off or land in a continuous turn over a 700-foot diameter area.

With maximum gross weights, the helicopter travels on take-off from 75 to 100 feet on the ground cushion before it gains sufficient speed to leave the cushion, and climb with translational lift. Upon normal approach for landing its speed is checked and a ground cushion picked up as it comes within 200 to 300 feet of the landing spot. The helicopter is then eased over the spot and let down from hovering to the ground.

If the helicopter is equipped with high lift blades, suitable landing gear and brakes, running landings and take-off could be made with full design gross weight (4,900 pounds) up to density altitudes of 10,000 feet. This would require a landing strip, but a much shorter one than required for conventional airplanes.

First Use of Helicopter in Fire Suppression

Although it has been verbally reported that previous use has been made of a helicopter to patrol fires in Florida swamp lands, its first recorded use on a going fire by the Forest Service, as part of the scouting and transportation facilities, is now part of the record of the Castaic Fire, Angeles National Forest, Region 5.

On the third day of the fire, September 9, 1946, a Sikorsky R 5–A with standard blades, furnished by the 62d AAF Base Unit, March Field Detachment, and piloted by Lts. Chuddars and Frost, arrived at the fire just in time to carry George Reynolds, Angeles Forest Engineer, on a scouting and mapping expedition of an 800-acre break-over into the rugged and inaccessible Red Rock Mountain area. Within less than three quarters of an hour the helicopter was landed in a 200-foot clearing at the fire camp (abandoned Castaic CCC Camp) in the bottom of Castaic Canyon, and an unusually detailed and accurate map of the fire situation was delivered to the fire boss. With any other means, including conventional aircraft, much more time would have been required and considerable important detail could not have been obtained.

Several additional flights were made from the fire camp during the remainder of the afternoon, and information continued to be reported from the helicopter by radio. Because of high obstacles adjacent to three sides of the landing spot, all landings and take-offs were made from one side quartering into the wind.

On the morning of September 10, work in establishing a fly camp on the summit near Red Rock Mountain was begun. This camp was to be dropped in and supplied by air. Elevation was 4,000 feet (density altitude approximately 7,000 feet). Since the helicopter was not stripped and not equipped with the new high lift blades, it could not land with a reasonable pay load at the dropping area. However, Lieutenant Frost and B. O. Hughes (Assistant Regional Forester, Region 5) succeeded in delivering cargo which was released free fall close to the ground and at speeds under 15 miles per hour. Later in the day, Lieutenants Frost and Reynolds dropped clean socks literally at the feet of the weary firefighters.

Throughout September 10, helicopter reconnaissance of the perimeter of the break-over continued until all hot spots were manned. During all flights the helicopter was subjected to severe gustiness, up-drafts, and downdrafts. Reports from pilots and passengers indicate that the helicopter was far less affected by these severe air currents than the twin-motored Beechcraft (AT–11) used in cargo dropping for the same fly camp.

Helicopter vs. Conventional Aircraft in Cargo Delivery

During the period of September 10 and 11, on the same Castaic Fire, 8,361 pounds of cargo (including chute and packaging) were dropped by the twin-motored Beechcraft (AT–11), which had been modified especially for this work. It required 9 flights averaging over 40 minutes each to deliver this cargo. From 5 to 7 passes of the dropping area were made to discharge each load. The average load was 929 pounds. It is estimated that approximately 800 pounds of each load consisted of equipment and supplies.

It is interesting to note the probable relative efficiency of a helicopter in this operation. Since the dropping area was a natural ridge top helicopter landing spot with density altitude of 7,000 feet, we find from table 2 that a stripped version of the R–5 (or S–51) with high lift blades could have easily carried 800 pounds of equipment and supplies on each flight and landed at the dropping area. By moving the air supply point from Newhall airport to the fire camp (Castaic CCC Camp), the flying time plus unloading time for the helicopter would have been from 15 to 20 minutes per 800 pound load. Besides the total time saved in delivering the supplies and in flying time costs, a considerable saving would have been made in packaging, cargo chutes, and preventing losses. At least five chutes did not open or failed during this operation, and equipment dropped free fall scattered considerably down the steep slopes.

Returning the fly camp equipment to a truck head is a costly pack animal project. A suitable helicopter could have transported it back to the main fire camp in approximately four 20-minute round trips. The transportation of men and supplies by suitable helicopter to the fire line is not discussed here. Such possibilities, however, were unlimited on more than 75 percent of the fire line for this particular fire.

Future of Helicopters in Forest Work

Although the information given in this article is insufficient for complete planning in the use of the helicopter, it is hoped that it will be inspiring to those who have long hoped for a successful machine. There is no doubt that there will soon be available helicopters suitable for forest fire control activities. Helicopters that will carry an adequate pay-load to the elevations with which we are concerned, and perform satisfactorily, have been field tested. It is expected that the several mechanical "bugs" now hindering the continuous operation of these ships will soon be eliminated. When this is done, the helicopter for forest-fire work will be ready to serve you.

Novel Method of Fire Area Measurement.—Region 5 reports a very ingenious method of measuring the size of a fire developed by one of their pilots. While flying across the fire at 120 miles per hour the observer presses his face against the window watching the trailing edge of the wing strut. As the strut crosses into the burn the observer calls "now" and another passenger begins timing with the second hand of his watch. When the other edge of the fire is reached the observer again calls "now" and the timing is stopped. Two flights are made in each direction to compensate for wind. In a case which was cited the data obtained was an average of 12 seconds one way and 6 seconds on the cross trip. With the speed of the plane at 120 miles per hour, 2 miles per minute, or 2.67 chains per second, it was determined that the fire was 32 chains long and 16 chains in average width. This indicated that the fire had spread over an area of 51 acres.

PRESCRIBED BURNING IN THE FLORIDA FLATWOODS

C. A. BICKFORD[1] and L. S. NEWCOMB[2]
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This discussion of prescribed burning is based on experience and studies of the use of fire as a tool in the elimination of hazardous fuels in the longleaf-slash pine forests of the flatwoods section of Georgia and Florida. It does not cover other uses of fire in the silvicultural control of diseases in pure longleaf pine and other southern forest types. Most of the practices described will, however, be found applicable to other types of prescribed burning.

By definition prescribed burning is a distinctly technical measure and a potentially dangerous tool. Mr. Arthur W. Hartman, Chief of Fire Control in the Southern Region, sounds a note of caution when he says this employment of burning is "the application of fire to land under such conditions of weather, soil moisture, time of day, and other factors as presumably will result in the intensity of heat and spread required to accomplish specific silvicultural, wildlife, grazing, or fire hazard reduction purposes." Consequently, fires set for any other purposes or set without expert knowledge of fire behavior under existing conditions of weather, soil moisture, time of day, probable wind, etc., are definitely to be avoided. Uninformed and misguided efforts to burn are almost certain to produce disastrous results.

Successful fire protection in the long-leaf-slash pine forests of the southeastern flatwoods markedly changes the composition of the stand. Under protection, slash pine, instead of remaining confined to ponds and swamp margins, reproduces vigorously and invades drier sites formerly occupied almost exclusively by open stands of longleaf pine. The stand is thus converted from nearly pure longleaf pine to one in which slash pine predominates. This change in composition is sought and welcomed by most owners and operators of forest land because of the rapid growth of slash pine and its high value for naval stores and other products.

Unfortunately, increase in fire hazard accompanies this beneficial conversion to slash pine. Under fire exclusion the grass roughs become heavy. Needles and twigs add to the inflammability, while the gallberry and palmetto undergrowth increases in size and density. Conditions often become particularly hazardous in dense stands of slash pine 10 to 15 years of age, where dead needles may be draped over the high gallberry undergrowth and the lower dead branches in an almost continuous screen from the ground to the living crown 15 to 20 feet above.

When a fire starts in stands unburned 10 or more years it spreads rapidly and is hard to control. Such fires often cause extensive and

[1] Forester, Northeastern Forest Experiment Station (formerly of Southern Forest Experiment Station).
[2] Forester, Naval Stores Conservation Program (formerly District Ranger, Osceola National Forest).

severe damage and become so much of a threat to the landowner that he is likely to give up the idea of growing timber on his land.

To decrease the threat of such fires, many foresters and landowners in this section have resorted to prescribed burning of accumulated fuels at intervals under carefully selected weather conditions. Slash pine about 6 feet in height and longleaf over one year in age can stand slow-burning prescribed fires during the dormant season. Experience demonstrates that burns carefully planned and executed in this season may temporarily eliminate the hazard of accumulated fuels without serious injury to the timber stand.

Osceola National Forest, Florida. Dense slash pine 15 years of age. Note dead needles draped over gallberry undergrowth and dead lower limbs. Wildfire in such a stand almost always results in a complete kill.

Prescribed burning to reduce fire hazard affects fire prevention, detection, suppression, and other fire control activities. Its justification depends on reducing the total costs of fire control in which incidental damage caused by the the burning is considered an item of cost.

This paper describes methods of prescribed burning developed and used on the Osceola National Forest in northeast Florida, a tract of 168,000 acres typical of managed forests in the southeastern flatwoods. On this area fuel accumulated in dangerous quantities for 15 years, during which time the presence of small slash pine throughout the forest made fire treatments impractical. As the slash pine began to reach a size where damage from slow-burning fire would be minor, trial burns were made. On the basis of these trials and other observations, plans were laid in 1943 to prescribe-burn approximately 100,000 acres of longleaf-slash pine in the following 3 years.

In the first year 39,130 acres were treated at a cost of 7.9 cents per acre, of which 0.7 cent was for planning, 3.2 cents for preparations (chiefly plowing fire lines), and 4.0 cents were direct costs of burning. Costs the second year for 33,100 acres were 6.6 cents per acre treated; planning 0.7 cent, plowing 3.7 cents, and direct cost 2.2 cents.

Damage from the first year's operations was estimated at 31.4 cents per acre treated, and in the second year at 8.7 cents. Because of general drouth and few periods of ideal burning weather, the damages sustained during the first year were greater than anticipated. Damages during the second year were reduced somewhat by the added skill and experience of the men conducting the work but primarily by the more favorable ground water and weather conditions prevailing. By treating a maximum area during good burning years and a minimum during unfavorable years, future damage should be held to 8 cents per acre or less.

Forest managers throughout the South, who after careful analysis determine that the use of fire for some specific purpose is desirable, will find the methods used on the Osceola National Forest helpful in planning and organizing their prescribed burning.

Methods Used

Prescribed burning, to give maximum benefits at the least cost and damage, involves the following steps: Analysis, planning, preparation, burning, and appraisal. Each step is important and necessary.

Analysis

To arrive at a satisfactory decision whether to use fire, an analysis of forest conditions must be made which will permit a sound comparison between the probable costs and damage and the expected benefits. Direct costs can be satisfactorily determined from data such as given here and from similar operations in the same forest type.

In the flatwoods, benefits are mainly in the reduction of hazard and the consequent reduction in the possibility of large and destructive fires. Damage will depend to some extent on the weather during the burning season, but most of all on the training, skill, and experience of the personnel. Although prescribed burning in this section will be most important to fire protection, its influence on grazing, silviculture, logging, game, turpentining, and other forms of land use must be carefully considered. The advantages and disadvantages of the practice vary widely from property to property and no simple and precise method of evaluation can be suggested. The practice should be undertaken, however, only after a careful analysis has convinced the owner of the need or desirability of the practice on all or part of his holdings.

Once he has analyzed his property and decided to burn, the owner must determine which areas to treat. Areas burned should ordinarily be distributed so as to serve as temporary firebreaks. Prescribed burning of areas of high fire incidence is a double gain, for the areas not only become safe themselves but also act as firebreaks. The detailed location of burning units should be decided only after field examination as described in the following section.

Planning

The prescription or plan is a most important phase of prescribed burning, distinguishing it from unorganized and often destructive use of fire. The prescription is prepared in the field at the time of examination. It specifies when and how to spread fire to achieve the greatest benefit.

The first step in planning is to make a field examination to secure the necessary data. On the Osceola National Forest experienced and responsible forest guards made the examinations under the direction of the District Ranger. In planning the use of fire on extensive areas, maps are prepared to show natural fire barriers, fire line locations, burning direction, areas to be excluded, usable roads and trails, and

Osceola National Forest, Florida. Slash pines gradually seeding in a former longleaf pine "ridge." Such stands cannot be treated successfully under prescribed burning because of excessive mortality in the crop trees below 6 feet in height.

other useful information. The examiners on the Osceola used aerial photographs for base maps on which to record such information. On small properties detailed examination and mapping may be unnecessary.

The size, abundance, and distribution of crop trees[3] determine where and how fire can be used. Small slash pine is easily fire-killed and extensive areas of slash pine crop trees under 6 feet high should not be burned. When the crop trees are slash pine 1 to 3 inches in

[3] In this work, the best trees at an average spacing of 10 feet were considered crop trees and smaller intermediate or suppressed trees were disregarded in planning the burning and in evaluating the results.

diameter at breast height, or longleaf from 1 year old to 3 inches in diameter at breast height, a backfire, that is, fire set to spread only against the wind, in the dormant season under proper weather conditions may be safely used. With crop trees 4 inches in diameter at breast height, or more, a flankfire is safe. A flankfire, set to burn at right angles to the wind, spreads faster and burns hotter than a backfire. Flankfires in such stands are cheaper to use and generally cause less damage than backfires. In the Florida-Georgia flatwoods, where young slash pine is common, a backfire is the usual prescription. On the Osceola, many stands otherwise suited for flankfire contain scattered groups of slash pine crop trees 1 to 3 inches in diameter at breast height, usually making it necessary to prescribe a backfire.

Small patches of slash pine crop trees under 6 feet high are often found in stands otherwise suited for burning. Whether to burn them with the rest of the stand or plow around them and exclude fire depends on the size of the patch, the number of small slash pine crop trees it contains, and its nearness to the fire lines needed to burn the rest of the stand. The tabulation below shows the smallest size patch found worth excluding on the Osceola National Forest. Smaller areas were often excluded when only a slight change was needed in the location of a plowed line.

Maximum area to exclude	Slash pine crop trees per acre under 6 feet tall
Acres	*Number*
6	50
5	70
4	95
3	135

The prescription first specifies type of fire, for all other steps depend on it. It then recommends preparatory work, mainly plowed lines to control the spread of the fire. Exterior barriers must be provided for all burning units; roads and streams should be used where possible to reduce plowing cost. Flankfire requires interior parallel lines about one-half mile apart to avoid too long a flank. Backfire requires a similar series of parallel lines close enough together that the area between them will burn out in the burning period. Backfire spreads about 1 foot per minute, and so 600 feet is the maximum distance between such lines unless more than 8 to 10 hours burning is planned. Since northerly winds are least variable, these interior lines are usually plowed in an east-west direction.

For most purposes the season for using fire is the late fall and winter after the first frost (about November 15) and before the beginning of needle growth in the spring. Prescribed burning should be completed before the start of the spring fire season, about March 1. It is desirable to burn as much as possible in wet years when the ponds are full of water. Day burning is easy to supervise and to do correctly, but night burning is necessary when minimum fire intensity is required. Plan to burn only when constant wind direction is forecast. As wind shifts and break-overs are the greatest source of damage, good burning

conditions are found when there is a 3- to 10-mile northerly wind in clear weather immediately after rain. Wind direction is commonly variable in the unsettled weather previous to rainfall. Wind shifts are also likely around noon and sunset. On the Osceola the northerly winds which prevailed 1 to 3 days after rains were the most reliable.

The prescription should also cover the size of crew and equipment needed. Motor equipment is used mainly to plow lines and to transport men and tools. Spreading and mop-up tools are needed for the burning job, and ample fire-suppression tools should be available in case of break-overs. Crew size is influenced principally by considerations of cost and safety. It is seldom safe to attempt prescribed burning with fewer than 3 men. Reasonable cost in relation to benefits requires that at least 10 acres be treated per man-hour; thus a crew of 5, including the leader, should treat at least 400 acres in an 8-hour day. Such a crew on the Osceola National Forest burned 500 to 1,000 acres per day (12½ to 25 acres per man-hour) setting as much as 10 miles of backfire and providing the needed mop-up and patrol. This crew was large enough to vary duties to meet particular fuel and weather conditions. At night, with no patrol, smaller crews may be superior, while if mop-up is needed it is better to have extra men than to take some away from the work of spreading fire. Continuous day and night burning can be used, if relief crews are available, to lower costs under exceptionally favorable conditions of weather, fuel, and stand. Good prescribed burning requires that crews be relieved after 8 hours of work.

All preliminaries and plans for burning should be completed by early fall to eliminate haste and consequent poor results.

Preparation

Preparation for burning consists mainly in plowing the lines provided for in the plan. Enough lines are plowed in advance to permit choosing one of several units on the burning day; yet, to prevent fallen needles and leaves from weakening the lines, plowing ordinarily should precede burning by not more than two weeks. Lines should be carefully located to minimize break-overs from hazardous fuels such as snags and thickets of gallberry. A two-disk plow such as the Mathis, drawn by a light tractor, will prepare a line about 6 feet wide at a cost of about $3.25 per mile. With several hundred miles of line to plow, such equipment is indispensable. Plowing and burning in one operation is inefficient since a line can be fired 3 times as fast as it can be plowed.

Burning crews should be selected and trained well before the start of operations. The plow operator needs to know how to read maps and aerial photographs and where lines should be located as well as how to operate and service his plow and tractor. Crewmen must be taught how to fire in relation to plowed line and hazardous fuels. Mop-up standards, changes to meet wind shifts, provisions in emergencies, etc., should be clearly understood by all. This training should be continued as long as necessary after burning starts. The continuity afforded by having the crew foreman examine, map, plan, and plow is desirable but seldom possible.

Reliable weather forecasts improve the quality of burning, and arrangements should be made to receive daily forecasts of wind direction and velocity, relative humidity, precipitation, and general state

of the weather. Forecasts twice daily at 12-hour periods are best; the first should be received by 8 a. m., before departure of the work crews, and the second before the usual quitting time.

Burning

Each day during the burning season the manager, guided by weather forecasts and experience, decides whether or not to burn and selects the best unit for conditions expected. With favorable weather low costs are achieved by spreading fire rapidly to increase area burned per man-hour.

To complete the burning job, the area should be mopped-up to prevent break-overs. The extent of mop-up will depend on the amount of dangerous fuels and on weather conditions.

Appraisal

Appraisal following burning may consist simply of field checks, or it may be a careful evaluation of both injury and benefits for the whole area. When crowns are not scorched above half their height, damage is minor: a few small trees are killed and growth on others is slightly reduced for a year or two. Scorching more than four-fifths of the crown results in excessive mortality and a sharp temporary reduction in growth rate of the survivors.

Recommendations

Prescribed burning methods used on the Osceola National Forest have been briefly described; the most important suggestions follow:

1. Use fire only when analysis reveals benefits should clearly exceed cost and damage.
2. Correlate prescribed burning with silviculture, grazing, game, crops, logging, turpentining, etc.
3. Prepare in advance (examine, map, plan, plow, etc.) so as to be ready when burning conditions are right.
4. Arrange for weather forecasts, especially of wind direction. A steady wind during the 8 to 10 hours required to burn a unit is of first importance in minimizing cost and damage; burn only when a constant direction is forecast for at least 12 hours.
5. Reduce costs when burning conditions are especially favorable by: (1) spreading backfire rapidly to have 10 or more miles burning at one time, and (2) using relief crews to take full advantage of favorable burning weather.
6. A competent crew is essential; it should be small and composed of reliable local men experienced in fire behavior and control.
7. The forester, to achieve efficient and successful prescribed burning, must use his intelligence, courage, patience, and determination.

OUTLINE FOR ANALYSIS OF FIRE PREVENTION ACTION AS APPLIED TO A PARTICULAR FIRE

All experienced fire control men agree that the most successful fire control job of all is the fire that was prevented from starting. We all give lip service and routine support to preventing fires, but too often we do not get down to cases and carry through on systematic plans and skillful application of lines of action to get real solutions. We need to cultivate the habit of regarding each preventable fire as a challenge to our resourcefulness and as a blot on our record. It is a game worthy of our best talent. The best solution often calls for more head work than figuring out the "who done it" in Sherlock Holmes style. "Who" is only one step. The even bigger job to every land manager is to arrive at "It won't happen here." That requires lots of team work!

In California, a great deal of thought and planning is now being given to the problem of arriving at this goal. In the process, Region 5 has devised an outline to guide the preliminary process of making a systematic analysis. If well carried through on a series of fires, one at a time, a sound plan of action geared to the local situation ought to evolve naturally. Here is their chart. Try it out, then see if you can devise a better one!

CAUSE

Get detailed facts of this. Seek basic cause that led to statistical cause.

- I. Preventable
  - A. What known fire prevention techniques were applied in this case?
    1. How identify hazard.
    2. Physical methods for abatement of hazard.
    3. How approach agency or person responsible.
    4. How inspire person or agency to undertake abatement.
       - a. Discussion.
       - b. Examples.
       - c. Sample demonstration.
       - d. Cooperative assistance.
    5. Enforcement methods possible to insure abatement.
       - a. Punitive measures (shut-down, etc.).
       - b. Cancellation of permit.
       - c. Legal action.
  - B. What is Forest philosophy concerning application techniques?

	a.	b.	c.	d.
1. How do	Supervisor and Staff.	Ranger.	FC Asst.	Guard.
2. What do	Supervisor and Staff.	Ranger.	FC Asst.	Guard.
3. When do	Supervisor and Staff.	Ranger.	FC Asst.	Guard.
4. Who do	Supervisor and Staff.	Ranger.	FC Asst.	Guard.

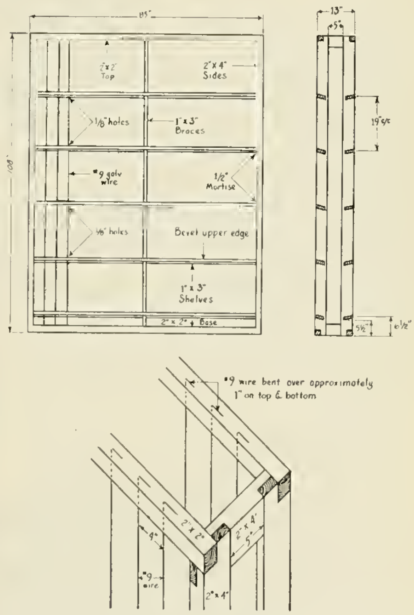
  - C. What actions taken in this case?
    1. Identify actions taken in accordance with A and B above.
  - D. Quality of actions taken?
    1. Positive
    2. Casual
    3. Negative

    Identify by facts.
  - E. Why did action fail?
    1. Follow constructive reasoning in arriving at conclusions.
  - F. How improve future action?
    1. Philosophy of responsibilities for action at all levels in B.
    2. Approach to agency or person responsible.
    3. Inspiration to agency or person responsible.
    4. Physical methods of abatement.
    5. Techniques, including identification of hazards.
    6. Application of enforcement measures.
- II. Nonpreventable Why?

HOSE STORAGE RACK

L. A. Horton
District Ranger, San Bernardino National Forest, U. S. Forest Service

A hose storage rack developed on the Mill Creek ranger district has found favor throughout the San Bernardino National Forest. It permits the maximum amount of storage with the use of the minimum amount of floor space. It also allows the hose to be well ventilated and permits easy removal and replacement of hose.



Storage rack with capacity of 3,000 feet of 1½-inch hose; and diagram of storage rack with capacity of 5,000 feet of 1½-inch hose.

Dimensions may be changed so that a rack may be constructed to fit the available floor space. The photograph shows a rack that has a storage capacity of 3,000 feet of 1½-inch C. J. R. L. hose and occupies a floor space of about 4½ square feet. The rack in the diagram has a capacity of 5,000 feet and occupies 8 square feet of floor space.

The rack is constructed by building two identical units (front and back) and fastening them together with 2- by 4-inch blocking as shown.

Bill of material for a rack of 5,000 feet capacity:

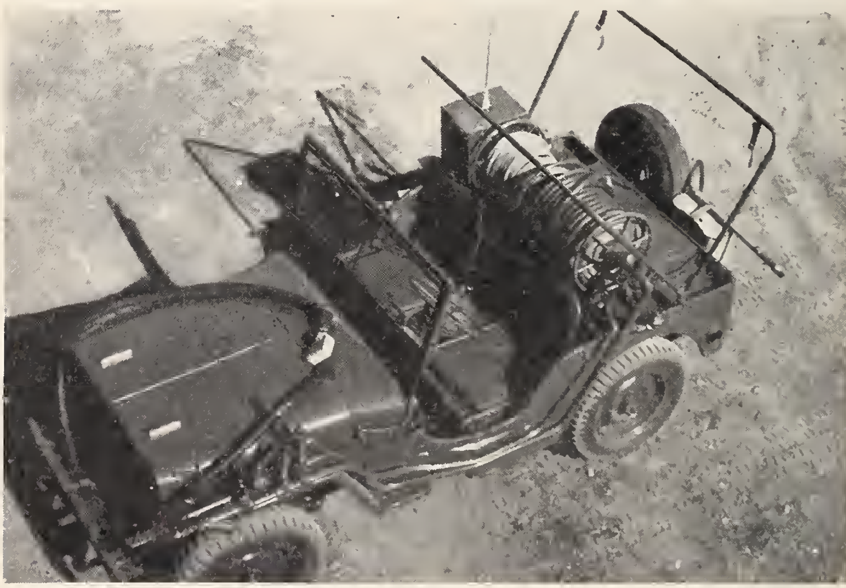
325 feet No. 9 galvanized wire.
4 pieces 2″ x 4″ x 9′ (sides).
1 piece 2″ x 4″ x 5′ (spreader blocking).
4 pieces 2″ x 2″ x 7½′ (top and base).
2 pieces 1″ x 3″ x 9′ (shelving brace).
10 pieces 1″ x 3″ x 7′ (shelves).

JEEP TANKER

H. M. White
Equipment Engineer, North Pacific Region, U. S. Forest Service

Region 6 has equipped five ¼-ton jeeps with water equipment and assigned them for the use of patrolmen in areas of special hazard. One is equipped with VHF radio and the others will be as soon as additional radios can be obtained.

The tank holds 60 gallons and was constructed to fill the space behind the seats. It is rectangular in shape, except that the front side is slanted to conform to the seat backs and the bottom is recessed at each side to fit over the snubber housing. A live reel, carrying 150 feet of ¾-inch garden hose, and a dead reel, with 150 feet of 1-inch rubber-lined hose, are mounted on top of the tank. The KUT-KUR radio is mounted at the end of the dead reel, with the antenna extending through a slit in the top. A canvas flap protects the radio controls when not in use. The microphone is mounted between the reels.

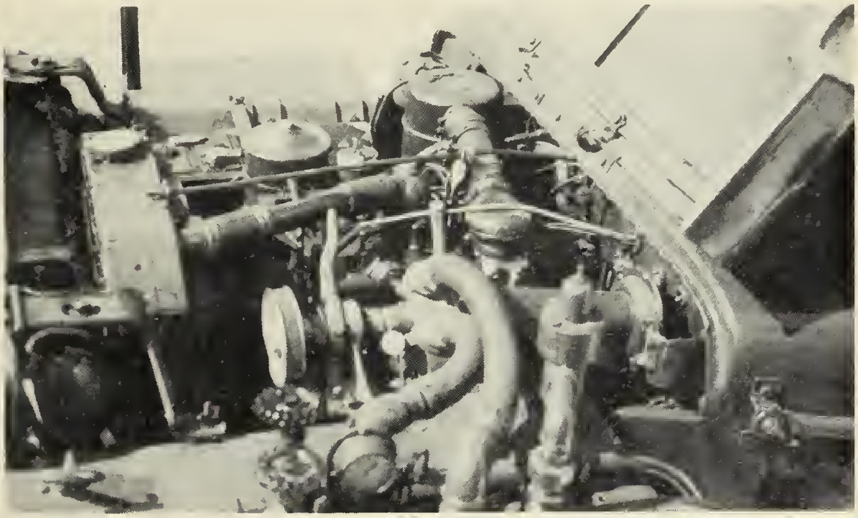


Tanker from above, showing part of tank, hose reels, pipe connections, suction hose, radio, back-pack can and pump, and spare tire.

It seemed better to mount the pump on the inside of the fender than to make the changes that would have been required to mount it on the engine block. The mounting chosen required a change in the

lower radiator connection to avoid interference with the fan belt. An intake outlet, with trap, and a 1-inch discharge outlet are provided at the front.

The intake line from the tank and the discharge line to the live reel are made of 1-inch copper pipe, obtained from Navy salvage. The valve arrangement permits filling the tank through its outlet to



Fan-belt pump, with intake and discharge connections, bypass valve, and pressure gage.

the pump. The only practicable place to carry the 1-inch suction hose is on the hood, as shown.

The fire equipment carried consists of Pulaski, No. 0 shovel, back-pack can and pump, canvas bucket, 1-gallon canteen, and headlight. The mounting for the back-pack pump was changed after the pictures were taken, because if mounted on the can, as shown, it would be subject to damage. To avoid this, clips were installed on the top of the tank immediately in front of the can and spare tire. The shovel and Pulaski are mounted on the right side of the truck body above the rear wheel. The other articles are carried in the glove compartment, between the seats, and under the right hand seat. A low box between the seats would, no doubt, be convenient for small articles.

Preventing gumming of back-pack pumps.—An excellent preventative for sore and aching arms and gummy back-pack plunger barrels was offered by Fire Control Assistant Davis of the Descanso District, Cleveland National Forest. By cleaning the plungers with solvent and then rubbing them with a bar of soap, they do not become gummy or dirty and, during use, furnish their own lubricant.—REGION 5.

PRELIMINARY REPORT ON AERIAL DETECTION STUDY

R. L. HAND and H. K. HARRIS
Foresters, Region 1, U. S. Forest Service

This paper reports a study to determine the most economical combination of ground and air detection, based on percent of coverage and frequency of observation. It does not attempt to prove that air detection is or is not superior to ground detection. Such proof would require the study of many additional factors.

Among the various uses of airplanes in fire control work in the western regions, aerial detection must be regarded as something of an anomaly. Although initiated nearly thirty years ago and used more widely than any other type of air service, it is generally regarded as merely an adjunct and in no sense a substitute for the old-fashioned ground or fixed detection system. Other uses of airplanes in fire control, such as the hauling of freight and passengers, cargo dropping, and aerial photographic mapping have been analyzed and compared with the older methods on cost and efficiency basis. So has smoke jumping in recent years. In every instance it has been found that each of these services has paid its way in better results or lower costs under given conditions.

It is our belief that the development of aerial detection has been hampered and delayed because of the traditional attitude toward so-called air patrols, though they have been, it is true, pretty much of a hit-or-miss proposition in the past. There are certain clearly recognizable, but not necessarily inherent difficulties and limitations in spotting fires from an airplane and these seem to have influenced the belief that no common ground could be found on which to base comparisons between air and ground detection. This study was to find a common ground and make comparisons.

Planning the Aerial Fire Control Experiment

In 1945, Region 1 embarked on an aerial fire control experiment involving some two million acres of inaccessible forest land. Ground detectors were reduced to a skeleton force and suppression was handled largely by smoke jumpers within this area, which, because it lies astride the Continental Divide, is usually referred to as the "Continental Area." This forest was selected not because it is especially adapted to the practical use of air detection, but merely to illustrate the principles involved.

In carrying on this experiment it was found that some system on which to base the comparisons was necessary. This resulted in a detailed study, the purpose of which was to determine at what point air detection should be substituted for ground detection on a sound economic basis. The preliminary findings are presented here with the full realization that they are tentative and incomplete. It will require at least several seasons of cautious and painstaking application of

the indicated principles on an experimental basis before we are ready for an all-out regional aerial fire control plan.

Standards for Comparison

As a basis for evaluating ground detection, Hornby's detection coverage curves were used. (See "Fire Control Planning in the Northern Rocky Mountain Region" by L. G. Hornby, page 73, fig. 20.) The average of these curves, when projected outward, indicates that in Region 1 approximately 500 lookout stations per million acres would be required to give 100 percent coverage. While absolute, complete coverage even with this number of lookouts is of course theoretical, it is reasonable to expect that a detection force of that intensity would give at least 95 or 96 percent, which for all practical purposes may be regarded as full coverage.

In addition to establishing a fixed point for the maximum degree of coverage, it was necessary to arrive at certain standards of frequency in observation that could be applied to both ground and air detection. Obviously, what we have thought of as constant detection is not constant at all, since no lookout can possibly see all of his visible area all of the time. A ground detector might be expected to spend 15 minutes of each daylight hour in actual observation, more constant observation being too severe a strain on the eyesight of the average individual. To put it in another way, all of the lookout's seen area comes under direct observation once each hour during the daylight period, which, for convenience, has been set at 16 hours per day as a maximum. This is closely in line with common practice in Region 1. The actual frequency is much greater than indicated because of the enormous overlap in visible area. This is equally true in air detection. Frequency of observation, combined with degree of coverage were thus set as the standards to be applied for comparison between air and ground detection.

To establish a curve for air detection that can be directly compared with the ground-detection curve, it was necessary to determine the total hours of flying required to maintain the hourly observation frequency rate over a 16-hour period. This was done in the following manner:

First, sample blocks representing different topographic types were selected from three widely separated areas, and these were profiled to determine flight courses and degrees of coverage obtainable (see A). Flights were projected across the sample areas, and by means of the profiles, seen area was computed for each trip until approximately 100 percent coverage had been obtained. By this means, fixed points could be established upon which to base an air detection curve. Flight time was computed for each trip, using an average ground speed for the slow planes used for present-day detection patrols, and the total applied to the million-acre unit by means of a conversion factor.

In working out the sample units representing different types of terrain, it was determined that from three to five trips, depending upon adaptability of the topography to air detection, would give from 95 to 99.4 percent coverage. Refinements made during later studies indicate that these percentages are conservative. Thus, the number of flying hours required to meet the frequency standard can easily be determined and a curve established that can be compared directly with

Hornby's curves based on the ground lookout system. The profiles were made at 1-mile intervals, approximately across the lines of flight, and from these profiles the final courses and flight altitudes were established to give the maximum coverage with the minimum amount of flying. Fuel types, special risk areas, contributed coverage (that seen from fixed lookouts), and the influence of topography on flying conditions often require adjustments, and these factors can all be given consideration when the profiles are made. Studies are under way at present to refine these "seen areas" by the addition of angle profiles, although it is of course realized that any appreciable degree of refinement must be followed up by adequate provision for the intensity of observation needed—probably requiring two observers on the more intricate courses. The profile method of determining flight courses and altitudes was used in the Continental Area during 1945 and 1946 with apparent success.

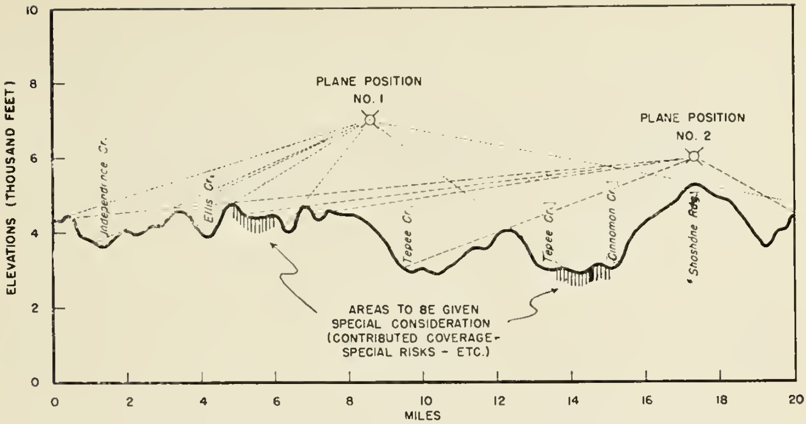
Cost Comparisons

As plotted on a cost basis, the air detection curve quite naturally starts at a higher level but increases at a lower ratio than the ground detection curve, and this is true up to a very high degree of coverage. With the ground organization, it has been determined that even under the most favorable conditions and where the justification is greatest, about 80 percent coverage is the limit that can be attained economically. Therefore, by plotting the two curves on a similar scale, it is possible to show graphically the theoretical point at which ground detection should be discontinued and air detection taken up to meet any particular situation.

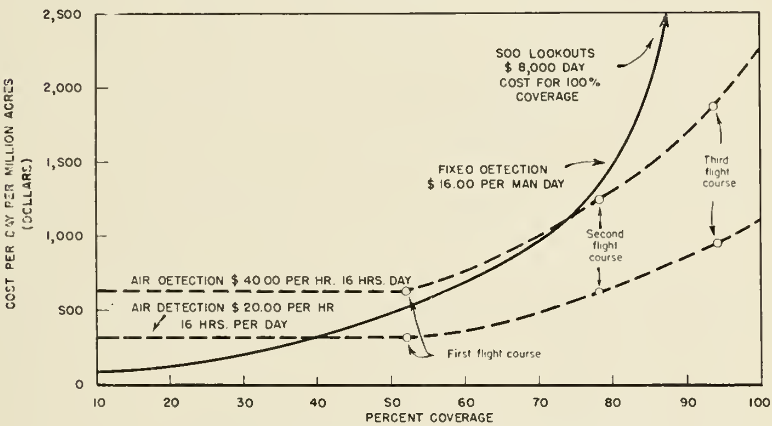
The detection data for ground coverage as worked out for the Coeur d'Alene Forest were used. For the past 7 years all forests in the region have had their fire control plans based upon an established rating for warranted degree of coverage, and that rating for the Coeur d'Alene is set at 79 percent. This means that the forest should have 79 percent of its area under direct visibility within an 8-mile radius when the danger class has reached 70, indicating the need for a full, normal-season organization. To obtain that degree of coverage in this instance requires the manning of 88 lookout stations per million acres, at a present-day cost of $16 per man-day for salaries and subsistence, and including prorated overhead.

We have no definitely fixed per-hour rate for air detection to correspond with the $16 per day ground detector rate. Forty dollars per hour is the present rate for our contract Travelairs, the planes we frequently use for patrol because they will also accommodate two fully equipped smoke jumpers. As nearly as we can determine, $20 per hour is a liberal rate at present prices for fully adequate types of ships for straight observation flights over mountainous terrain. Rates will vary greatly according to conditions and in an actual case it would be necessary to determine the rate specifically for the area under consideration.

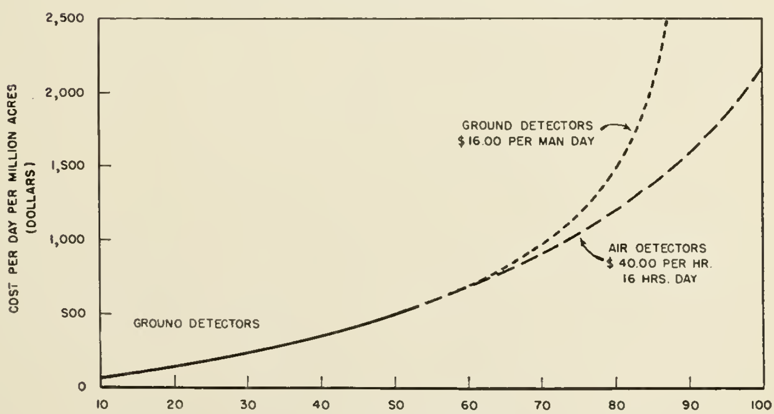
Now let us see what happens when we apply the corresponding air detection coverage on a cost basis (see B). It costs so much to put one plane in the air and to maintain the desired frequency standard that below 52 percent coverage there is no reduction in cost. One flight course, properly selected, will give 52 percent coverage. Subsequent courses add relatively less, as would be expected, although



A.- CROSS-SECTION PROFILE - AIR DETECTION



B.- COMPARISON OF AIR AND FIXED DETECTION
COEUR D'ALENE NATIONAL FOREST - REGION I



C.- COMBINATION - AIR AND FIXED DETECTION
COEUR D'ALENE NATIONAL FOREST - REGION I

the point of diminishing returns is met at a much higher percentage level than with ground detection, because of the flexibility of the air coverage. It was found that adding a second flight increased the coverage to approximately 78 percent, while a third flight brought it up to 93.5 percent.

Any interested person can determine a specific rate for his particular area and figure the comparative costs from the chart by interpolation. At $40 per hour for flying time (cost to include time and expense of observer as well as overhead elements) the air detection curve crosses the ground detection curve at 73 percent, which indicates that all coverage in excess of this figure can be obtained more cheaply by air patrol. At $20 per hour the corresponding figure is 39 percent.

These direct comparisons indicate what might be expected if air detection was substituted for the fixed lookout system. However, the most economical method would be a combination of the two, and the cost relationship can be determined by observing where the ground detection curve becomes steeper than the corresponding air detection curve (see C). Using the $40-per-hour figure, we find that fixed detectors should be placed in sufficient intensity to give about 55 percent coverage, which requires 37 positions per million acres. Further reference to the same chart indicates that the remaining coverage required to build up to 79 per cent can be obtained by air patrol at a saving of approximately $250 per day.

These comparisons are based upon a high frequency rate of observation (15 minutes per hour). Such rates would not always be necessary, particularly in areas of low occurrence and low hazard. Even in the more critical units, there is a chance for great savings over and above those shown by the direct comparisons. The cost of a ground lookout system in isolated areas goes on day after day, hour after hour, even during those times when the danger has been temporarily relieved and detectors are not needed. In the air detection plan only the few observers are a fixed charge. On safe days planes are grounded or used for other purposes, and on many other days of low danger the frequency of observation can be drastically reduced. Also, it is evident that greater flexibility will allow vulnerable spots and critical situations to be covered with far greater intensity with air patrol than with the conventional ground detector system.

Another and probably much greater source of savings should not be overlooked. Even a moderately intensive ground detection system involves a large investment in improvements, servicing facilities, and other elements not included in the foregoing analysis. In the Continental Area, for example, some 40-odd ground positions were eliminated, 32 of these being detectors. The cost of maintenance and replacement of living quarters, observatories, transportation and communication systems that were needed simply to service this organization amounts to considerable. To this should be added the operating and upkeep costs of pack stock, trucks, and warehouse space, together with the servicing personnel and the additional overhead required to recruit, train, and supervise a force of 40 men scattered over 2 million acres of roadless wilderness. Such considerations, while not included in the data, may be regarded as tending to balance some of the real or ostensible advantages of ground over air detection.

INSTRUCTION FOR PRESERVATION OF FIRE EQUIPMENT BY ARMY METHODS

NELS H. ORNE, *Engineer*
Forest Products Laboratory, Madison, Wis.

During the war years the Matériel Containers Division of the Forest Products Laboratory conducted corrosion experiments in conjunction with the Army Service Forces in which the use of various corrosion preventatives were studied. This article, or set of instructions, was prepared at the Laboratory at the request of the Division of Fire Control, after the author had completed a detailed report entitled "A Study of Army Service Forces Methods of Preservation for Use With Fire Control Equipment." The use of these methods for various types of fire tools should greatly reduce the substantial losses resulting from deterioration. The Laboratory maintains lists of the suppliers of these preservatives and can furnish names upon request.

Army Service Forces methods of preservation were developed for many types of equipment and varied field and storage conditions. Preservation methods were based on the nature and function of the surfaces needing protection, as well as the types of exposure and degree of preservation desired.

Of the various preservatives available a number are considered suitable for fire control equipment. They may be readily applied with limited facilities.

The nature of the surface is one of the important considerations. Surfaces classified as noncritical, those which are not highly finished or operating surfaces, may be treated with a hard-drying, thin-film preservative. This category includes surfaces of hand tools such as shovels, axes, and brush hooks, as well as larger surfaces like those on fire line plows and other power equipment. For surfaces that are classified as critical, a soft, thick-film preservative is suitable. Critical surfaces include highly finished, operating, or machined surfaces, such as the external moving parts of pumps, plows, and power equipment, and cutting surfaces of saws, augers, and like equipment. Preservative lubricating oils are available for internal surfaces of engine assemblies and pumping equipment.

Cleaning Before Preservation

All equipment, in order to be effectively preserved, requires satisfactory precleaning. The degree of cleaning depends entirely on the character of the surface to be preserved. Noncritical surfaces can be cleaned for preservation with steel wool or a wire brush. Grinding is satisfactory, where adaptable. It is also advisable to soak or wipe the areas with a petroleum solvent or kerosene before applying the preservative. Critical or operating areas should always be wiped or soaked clean with a petroleum solvent before preservation. Crocus cloth is recommended for removal of corrosion in the cleaning process.

Preservation of Noncritical Surfaces

The hard, thin-film preservative recommended for preservation of noncritical surfaces dries to a coating the consistency of wax after application and the evaporation of the solvent in it. The preservative is available under Army Ordnance Tentative Specification AXS–673, Compound, Rust Preventive, Thin Film, and also under Army-Navy Aeronautical Specification AN–C–52, Compound, Exterior Surface, Corrosion Preventive, type 1. Although the preservatives available under the two specifications are basically the same, AXS–673 appears to offer the harder film. Equipment treated with the preservative can be used without its removal, although this should be governed by the use to which the equipment is put. The preservative is applied cold, either by dipping, brushing, or spraying. It is removed, where necessary, by soaking in kerosene. This removal can be accelerated if brushing or wiping is used in conjunction with the kerosene bath.

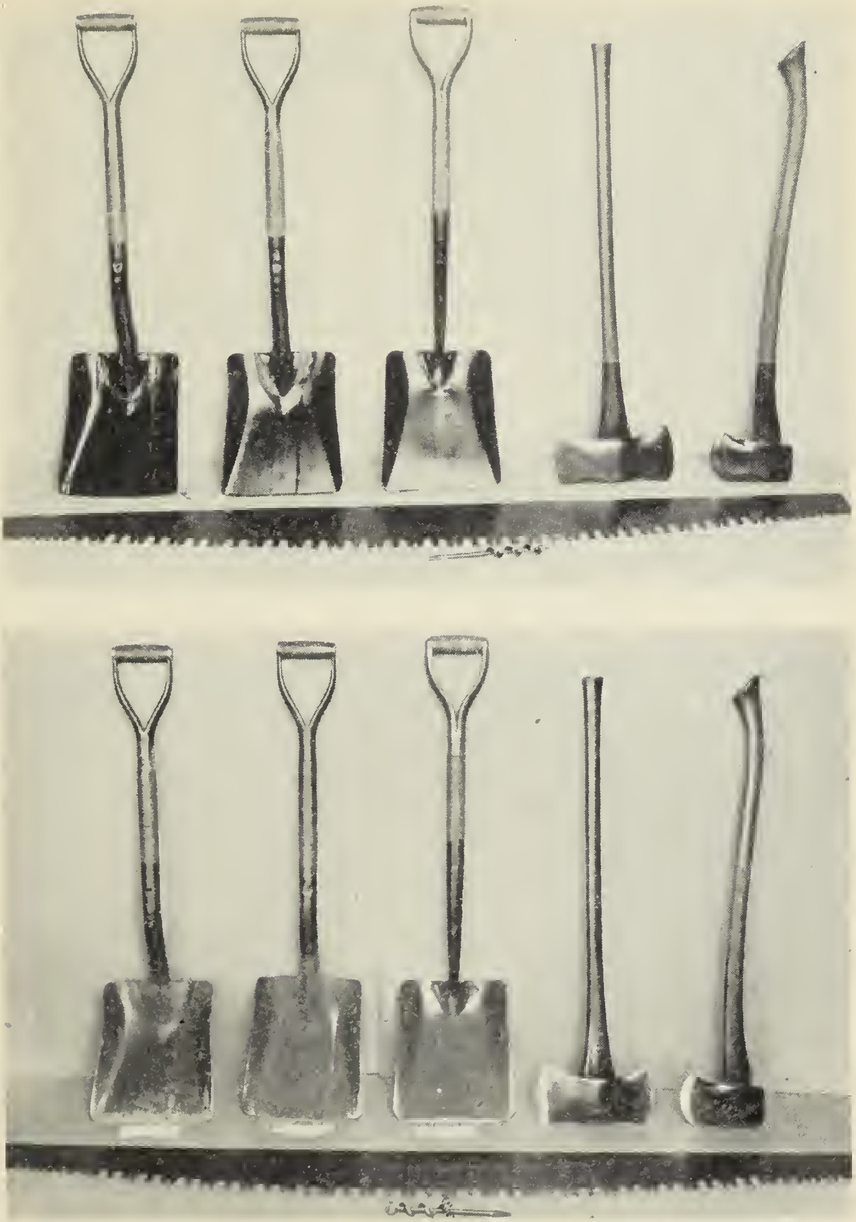
Preservation of Critical Surfaces

The soft, thick-film preservative recommended for use on critical surfaces is available under U. S. Army Specification 2–84, Compound, Rust Preventive, Light. It is a soft grease which may be applied cold by brushing at temperatures above 60° F. or by dipping in the preservative, where the size of the piece of equipment permits, with the preservative at 130° F. Surfaces coated with this preservative should be covered with a greaseproof wrap of any grade or type to facilitate handling. The soft consistency of the preservative permits the removal of a major portion of it by wiping without the use of a solvent, and complete removal by soaking in kerosene. Brushing and wiping while in the kerosene bath will accelerate the removal of this preservative, especially on parts hard to reach.

Preservation of Internal Surfaces

If an engine or motor is to be stored, the preservative most suitable for its internal surfaces is a lubricating oil containing a rust inhibitor. A preservative recommended for internal combustion engines is available under Army Ordnance Tentative Specification AXS–934, Oil, Engine, Preservative. The preservative is available in grade 1, equivalent in viscosity to SAE 10, and grade 2, equivalent to SAE 30.

Gasoline engines which have been operated on leaded gasoline must have their fuel tanks and crankcases drained and the engines then operated on unleaded, undyed gasoline for a 10-minute period, with the crankcase filled with grade 1 preservative. If the winter grade of oil, SAE 30, is specified because of special conditions, grade 2 preservative should be used in the crankcase. Where the engine has been operated on unleaded gasoline, the run period should be reduced to 5 minutes. Upon completion of the run period, seal the breather opening to the crankcase and drain the fuel and water-cooling systems. Seal openings after draining. Tape conforming to Joint Army-Navy Specification JAN–P–127, Tape, Adhesive, Pressure-Sensative, Water Resistant, type II, grade B, is recommended for sealing the openings.



Hand tools treated with preservative AXS-673: upper, before being put to a use-test; lower, after.

Attach a red tag to the oil filler cap; tag to read: "CAUTION—This engine has been treated for storage ———— (Date), and contains preservative engine oil. Drain and refill with seasonal engine oil before putting into service."

For protection of internal operating surfaces other than in engine assemblies, a preservative available under U. S. Army Specification 2–122, Oil, Lubricating, Preservative, Medium, is most suitable. This oil is an inhibited lubricating oil of vicosity SAE 30. It may be applied by dipping, brushing, spraying, or pouring into the interior surfaces. The preservative may also be used where an exterior surface coating is desired, although for satisfactory protection the piece of equipment should also be packaged in a waterproof package.

Army Range Finder Impractical for Fire Detection.—During the 1946 fire season Region 3 tested a standard U. S. Army Range Finder M–1916 for its usefulness in fire detection work at a tower in the Cibola National Forest, N. Mex. Because of its 1-meter square base and large mount the range finder could not be placed in the tower cabin. It was set up in the open at the base of the tower, thereby forcing the lookout to descend and ascend the tower for each observation. It was usually necessary to move the range finder to a different location for each smoke because of obstructions in the line of sight at the tower base.

The actual method of operation of the instrument is quite simple, and can be taught in a few hours to any individual of normal intelligence and normal vision. Unlike a transit or level, however, an abnormal amount of assiduous daily practice for several weeks or more is required before satisfactory competence can be attained. This is due to the manner in which the observation is taken. An accurate observation demands that an inverted image and an erect image of the target be brought just to, or only very slightly equidistant from, a horizontal line, and simultaneously in line vertically. Inexperienced observers may be surprised to find two successive observations on the same target give a difference in range of as much as 2,000 yards. Even experienced observers seldom obtain the same range on successive observations. In battle use, observers usually take five observations, select the two closest together, and use the mean range between these two.

The range scale on the finder reads from 400 to 20,000 yards, or roughly ¼ to 11 miles. The lower limit is no handicap. The upper limit, however, is somewhat less than the normal visibility in Region 3. Also, slight adjustments in alinement of images can change the range of a distant fire 1,000 yards.

The type of target usually encountered in fire detection adds to the possibilities of error. Battle observers try to pick sharp, well-defined objects such as buildings. The lookout, however, normally has a poorly defined target: a smoke column where it meets the ground or horizon. Such a target is almost impossible to bring into proper alinement.

From the experience in Region 3 with the Army Range Finder M–1916, these conclusions are drawn:

1. The amount of training and practice needed to insure a satisfactory standard of competence limits the use of this instrument to cases where observers will be more or less permanent.
2. Reasonably accurate observations of range were made on a maximum of 50 percent of fires within 5 miles of the lookout, and a maximum of 10 percent beyond 5 miles.
3. The size, shape, and character of the instrument itself makes its use very inconvenient at the average lookout.
4. The inspection, performance testing, maintenance, and repair needed to keep the instrument up to a satisfactory standard will add appreciably to someone's work load and will be expensive because it would require specially trained men.

W. Ellis Wiltbank, *Cibola National Forest, Region 3.*

WE PRODUCE FIRE TRAINING FILMS

J. Whitney Floyd

Chief Forester-Fire Warden, State of Utah and Professor of Forestry, Utah State Agricultural College

We needed fire training films. Together *We* are producing them.

During those man-shy fire years of 1942 and 1943 we, the fire control agencies in Utah, found ourselves faced with a huge fire control program but short-handed for men. The short-term men were too inexperienced and inadequately trained to cope properly with the fire training and suppression responsibilities at hand.

Something had to be done and a promising source of help was the Forest Fire Fighters Service being sponsored by the National Office of Civilian Defense. This we organized on a State-wide basis. We proceeded to recruit and train volunteer fire fighters to replace our former forces of Civilian Conservation Corps crews and regular personnel, who were largely in military service.

Our first State-wide training program was undertaken in the spring of 1943 with a three-man training crew made up of a representative from each of the following agencies: United States Grazing Service, United States Forest Service, and the Utah State Board of Forestry Fire Control. This team assisted every county Forest and Range Fire Fighters Coordinator in the State to train the volunteer fire fighters. One training deficiency was very noticeable. Aware of the most up-to-date Army training methods, trainees and trainers alike, repeatedly expressed their desire for visual aids to be used for training in brush-grass fire fighting techniques.

At the conclusion of the spring training program the training team expressed to the State Forest Fire Fighters Service Committee a general interest in producing a fire training film that could be locally adapted and applied. On August 20 of 1943, the State Coordinator called a meeting of his committee to consider the possibility of the fire control and land administering agencies cooperatively producing a fire training film. Subsequently, a questionnaire was sent out to the field personnel of the Forest Service, Grazing Service, Park Service, Extension Service, Soil Conservation Service, and Indian Service, and to State Forestry employees, asking for suggestions and opinions regarding what type of film they thought should be most suitable.

Ninety field men from the States of Idaho, Nevada, Wyoming, California, and Montana, expressed themselves in writing as to the needs and the quality of a brush-grass fire film. On December 10, the State Coordinator of Utah called a meeting of representatives from Idaho, Nevada, and Utah, to discuss plans for financing and organizing for the joint production of a brush-fire training film. The following points were discussed and agreed upon:

1. There is definite need for a fire training film covering fire suppression in cheatgrass and grass-brush types, and limited to the local area of Utah, Nevada, and Southern Idaho where cheatgrass is a big problem.

2. It should be 16 mm., in color, with sound, and be voiced by a narrator.

3. It should be simple, direct, and start right into action on suppression training with very little prevention or introductory material.

4. It should be directed to cooperators, per diem guards, and small volunteer crews—all with very little or no training.

5. It should not be over 30 minutes long—shorter if possible.

6. It should be limited to a small problem, a 5- to 7-man job, and should deal with the action expected to be taken on a small fire, using common hand tools—shovel and Pulaski tool.

7. In the development of the small problem the following points are desired:

a. A small fire, 3 to 5 acres.

b. As representative as possible of our intermountain foothill country.

c. Use of relief models or sand table terrain on which fuels and burning conditions can be pictured in total so that the entire problem can be seen and visualized by the trainees.

8. The presentation of the problem should develop the chronological steps of handling a suppression job, with emphasis on the various parts:

a. Preparatory arrangement and going to the fire.

b. Sizing up the situation.

c. Stopping spread.

d. Completing control line.

e. Mopping up.

f. Staying with fire or checking later.

9. Financial arrangements among the cooperating agencies should be informal to avoid complex and cumbersome agreements.

10. To appoint a production manager with full authority to arrange for the scenario, to select the areas for filming, and to requisition contributed help and facilities from the cooperating agencies.

A committee of three men—a chairman with authority to represent Idaho, Nevada, and Utah on both State interests and State Forest Fire Fighters Service; a representative of the United States Forest Service; and a representative of the United States Grazing Service—was appointed to act as an executive committee to determine policy and make major decisions. With this organization and informal financial agreements, we approached the problem in the winter of 1943. A scenario was prepared by the over-all committee, and field shots and indoor shots were taken. The committee as well as the field crews used in staging the scenes were employees of the various agencies. Each man became so absorbed in his job of producing a training film that the entire project progressed as a purposeful task without agency affiliation. The finished film, "Grass and Brush Fire Fighting," was released in March 1945. It has been credited by many of our control agencies as being one of the best of its kind produced to date. The cost of the film, including the contributed time of employees, travel expense, and cash outlay of all agencies, amounted to $7,307.42.

Our success in film No. 1 encouraged us to undertake a similar but more difficult project. On November 29, 1945, this same committee renewed its efforts to produce another film, "Fighting Large Brush and Grass Fires." The objective of this film, with emphasis on organi-

zation and communication in fire fighting, is to demonstrate the fire control techniques used in fighting large brush-grass fires with heavy equipment. Inside filming on an actual scale relief model was completed in the early spring of 1946 and the field shots were taken during the summer. Cutting and splicing the film, and adding the narration, are being done now. It is hoped that this film will be as useful for training fire fighters as was the first one.

Film No. 1, "Grass and Brush Fire Fighting," was finished by the Calvin Co., 1105 East Fifteenth Street, Kansas City, Mo., and may be purchased for $110. The State Foresters of Idaho, Nevada, and Utah; the U. S. Forest Service; and the U. S. Grazing Service have copies in their libraries for local use.

The New Ration E.—On September 18 about a dozen men sampled the new Army Emergency Ration, type E, at a luncheon arranged by the Equipment and Supply Section of the Division of Operation in the Washington Office of the Forest Service. Among those present were Messrs. Loveridge, McArdle, Campbell, Kramer, Godwin, Brown, Holden, and Kaylor. The group appeared to enjoy thoroughly the "ration luncheon," and the new ration was found generally acceptable to all.

The War Department advises that ration types K and C will be replaced by type E in the very near future. The Forest Service procured from them one case of the new type E for experimental purposes. Each case contains 48 cans, 8 accessory packets, and 8 cigarette packets. It is known as an 8-man ration case, and is designed to subsist 8 men for 1 day, or 1 man for 8 days. Each ration includes 1 accessory packet, 1 cigarette packet, and 6 cans (2 meat, 1 fruit, 2 B-units, 1 bread).

The 48 cans and 16 packets in the case procured were as follows:

8 B–1 units (a breakfast unit with cocoa and 1 unit of coffee, sugar, crackers, jam, and cereal).
8 B–2 units (a supper unit with 2 units of coffee and 1 of orangeade, candy, crackers, cookies, jam, and sugar).
8 bread (white).
8 fruit (cocktail).
4 hamburgers and gravy.
4 pork and beans.
4 pork and rice.
4 meat and beans.
8 accessory packets (gum, granulated salt, heat tablets, salt tablets, toilet paper, and can opener).
8 cigarette packets (9 cigarettes and 1 match book).

The meat and fruit units will vary according to the particular case received, since there are available 10 different kinds of meat items and 4 fruit items. Other meat units are chicken and vegetables, beef stew, frankfurters and beans, ham and lima beans, meat and noodles, and meat and spaghetti. Peaches, pineapples, and apricots are the remaining fruit units.

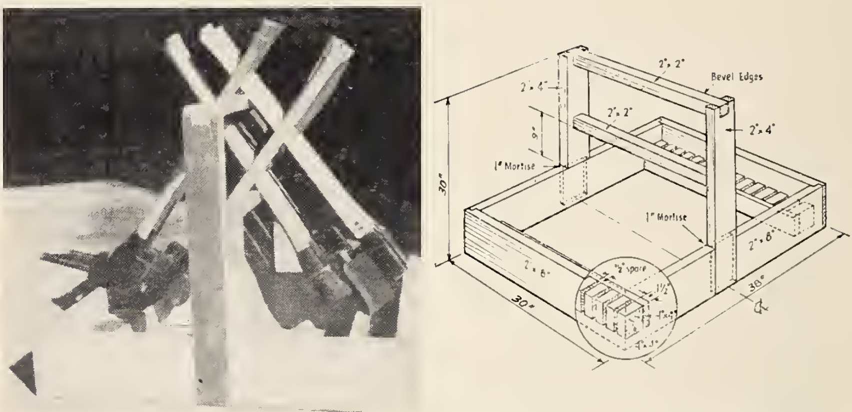
The E assembly permits considerable choice and more variety than the C or K rations. Also, it has more bulk and better palatability than the K. However, it is not so neatly separable into one- or two-man meal units as the K, which was popular because of its compact packaging.

One case of E rations has been sent to each Forest Service Region for sampling and comments.—John B. Holden, *Equipment and Supply Section, Washington Office, Forest Service.*

BRUSH HOOK RACK

L. A. Horton
District Ranger, San Bernardino National Forest, U. S. Forest Service

Convenience, safety, and a large storage capacity are the merits of a brush hook rack developed on the Mill Creek Ranger District. The rack is designed to hold 50 brush hooks placed in alternating positions, i. e., 13 blades down and 12 blades up on each side. This arrangement allows the backs of the 13 hooks to act as safety guards for the other 12. The blades of the hooks on each end of each row should always be placed down for safety. The tool handles are interlocked on the top and bottom cross bars. Two heavy chest handles on each side of the rack facilitate moving the rack or loading the unit on a truck without removing the hooks.



Rack with brush hooks in position, and diagram showing details of construction.

Tractor Transportation on Fires.—Forest officers have from time to time discussed the use of tractors in transporting supplies to isolated fire camps. Usually discussion centers around the use of stone boats or some arrangement of wheeled trailers. On the East Creek Fire on the Mineral District in 1945, a 55 tractor supplied the Eagle Creek Camp throughout the period it was occupied. The maximum number of men in the camp was 35, but the tractor could have supplied many more.

No stone boats or wheeled trailers were used. Division Boss Payne, faced with the necessity of moving a 35-man camp into isolated Eagle Creek, used alder poles, No. 9 telephone wire, spikes, two-by-fours, but mostly ingenuity to arrange a carrier on the principle of the Indian travois. Alder poles were inserted under the bulldozer hoist arms and wired to the frame work. These poles extended about 6 feet to the rear of the tractor on either side. Two-by-fours were spiked from pole to pole.

On this platform the camp equipment, mess gear, stoves, and bedrolls were piled. The load was covered with a canvas and securely lashed down. "She was big and cumbersome," said Payne, "but she got there. She was complete with tarp and all. We could have even thrown a diamond hitch, except I have forgotten how it's done."

On this particular job the country was so steep the tractor could not have made the return trip with either a stone boat or trailer. The travois arrangement performed satisfactorily on all the trips throughout the entire fire. The round trip distance was approximately 4 miles.—A. B. Everts, *Forester Snoqualmie National Forest, U. S. Forest Service.*

FEW FOREST FIRES IN GERMANY

Edward Ritter
Eastern Region, Forest Service

Go east, young man, if you are looking for a forest fire fighter's paradise. Incendiary bombs, phosphorous leaflets, tracer bullets, flame throwers, plane crashes—and yes, even cigarettes failed to start serious forest fires in western Germany during the war. From the small woodlots north of Cologne to the Black Forest of Baden, there was little evidence of forest fires. True enough, there were small burned areas in the Phalzerwald between Kaiserlautern and Ludwigshaven where a convoy of the Fuehrer's retreating supermen were strafed and their various vehicles and war machines went up in flames. In the Hurtgen Forest artillery air bursts damaged many trees. Considerable cutting by troops and forestry companies left much fuel on the ground. But the fall and winter of 1944–45 were cold and wet with much rainfall and snow. Even during the dry month of April 1945, however, there were no fires of consequence west of the Rhine.

After VE-day, in June 1945, about the time the British took over military occupation of the Rhine Province, a relatively large fire, nearly 600 acres, occurred in the eastern edge of the Hurtgen Forest. This was perhaps the largest single forest fire west of the Rhine during the last few years.

There was very little fire weather in northwestern Germany between July 1945 and June 1946. In Greater Hesse evidence of at least 100 fires was noted during the spring season of 1946. *Cause:* Probably hunter and warming fires, cigarettes, and incendiary. *Size:* From a few square feet to 10 acres. *Fuel type:* Spruce plantations 3 to 20 years of age with heavy crop of dry grass scattered throughout. *Damage:* Seedlings and young trees burned or badly scorched with mortality from 25 to 100 percent. *Percent forest area burned:* Estimated 0.025. *Risk:* Thousands of city people were in the forests continuously, chopping, carrying, and hauling fuelwood. Thousands of American soldiers were hunting, fishing, and wandering through the woods. Seventy-one thousand displaced persons from 20 different nations were in the process of repatriation during one 6-month period and the influx of another 57,000 added to the risk of the 4,000,000 German civilians who inhabited the area.

If forest fires were the most critical of the problems in Germany, we might be assured of a lasting peace as well as a forest fire fighter's paradise.

ARMY EXPLOSIVES FOR HAZARD REDUCTION

G. B. Johnson

Regional Fire Dispatcher, North Pacific Region, U. S. Forest Service

Many of the items developed by and for the Armed Forces during the recent war years are adaptable to forest fire control activities and the Forest Service has conducted tests to determine their practicability for this purpose. During the past year, in cooperation with the Army Corps of Engineers, tests were made with demolition explosives in felling snags.

Explosives furnished by the Corps of Engineers consisted of Tetrytol Demolition Chain M–1, Composition C–2, Composition C–3, Shaped Charge M2A2, and Shaped Charge M2A3. Three Army technicians, a commissioned officer and two noncommissioned officers, were assigned to the project.

Description of the Explosives

Tetrytol Demolition Chain M–1 consists of eight blocks of Tetrytol spaced 8 inches apart on a detonating cord (primacord) through the center of the blocks, with 2 feet of primacord on each end of the chain. Blocks measure 2 by 2 by 11 inches and weigh 2½ pounds each. Consistency of the explosive is hard and brittle. The velocity of detonation is 23,000 feet per second. Relative effectiveness as an external charge is 20 percent greater than TNT. Detonation may be obtained with a standard electric blasting cap attached to the primacord.

Composition C–2 is a plastic explosive of a consistency similar to putty and may be easily molded to obtain close contact for demolishing irregular shaped objects. Plasticity remains practically the same at temperatures ranging from 20° to 125° F. The explosive is packaged in blocks 2 by 2 by 11 inches, weighing 2¼ pounds, each block wrapped in glazed paper and enclosed in a cardboard carton. Eight blocks are packed in a cloth haversack with shoulder strap. A wooden powder box contains two haversacks. The velocity of detonation is 26,000 feet per second. Relative effectiveness as an external charge is 34 percent greater than TNT. Commercial explosives in the straight nitroglycerin and ammonia types of 60 percent strength have a relative effectiveness as external charges 83 percent and 53 percent, respectively, of TNT. A special Corps of Engineers' electric blasting cap or primacord is required for detonating C–2. This special cap is considerably stronger than a standard No. 8 cap.

Composition C–3 is similar in all respects to C–2 except that it is lighter in color and somewhat more plastic.

Shaped charges M2A2 and M2A3, designated as 10-pound and 15-pound charges, respectively, are identical except for the amount of

explosives they contain. They are also referred to as directional charges. The unit consists of a fiber container so shaped that a considerable part of the explosive energy is concentrated in one direction, resulting in an action known as the "Monroe effect." The explosive container is cylindrical with a cone-shaped top and a conical recess in the bottom. The explosive charge is loaded in the container at the factory. There is a detonator well in the top of the cone in which the detonator is inserted and secured by means of a plastic adapter. In the blasting operation the charge is placed on a fiber cylinder support, approximately 6 inches high, which keeps the charge at exactly the proper distance from the material to be penetrated. The action of these charges produces a penetrating effect rather than shattering. Several charges were tried on basalt rock with the following maximum results: One 10-pound charge penetrated 18 inches, and a second 10-pound charge placed over this hole deepened it to 32 inches; a 15-pound charge penetrated 28 inches, and another 15-pound charge placed over the hole deepened it to 44 inches. The diameter of both holes was 2½ inches. A special Corps of Engineers' electric blasting cap is required for detonation.

All of these explosives are highly inflammable. Tetrytol will burn at the same temperature as that required to ignite TNT. Fires are readily set when light fuels are dry and this is especially true when charges are not confined with stemming or mudcapping. They are exceptionally safe to handle because of their very low sensitivity as compared to commercial explosives and this accounts for the necessity of using a strong detonating agent.

Tests in Felling Snags

The tests were conducted in the old Yacolt burn on the Columbia National Forest. This area is the result of a disastrous fire which occurred in 1902, and while the fire-killed snags have been standing for 44 years, many of them are sound at the base. It was intended to make the tests on sound snags only but a few snags with varying degrees of decay were inadvertently shot. The latter are eliminated in determination of results obtained. All snags were Douglas-fir and ranged from 25 inches to 76 inches d. b. h.

Four methods of loading explosives were employed: (a) Sawed and chopped notches, unconfined and confined with mud, (b) auger bore holes, (c) external ring of Tetrytol Demolition Chain, and (d) Shaped Charge holes. Two notches, one each on opposite sides, and single notches were tried. Two cuts, with a saw, 4 inches apart and 5 to 8 inches deep are required for each notch. Wood was removed with a Pulaski tool. In boring holes for loading internal charges a portable electric power auger was used. This method is described in the Fire Control Equipment Handbook.

Results

Results obtained were as follows:

(a) After several trial shots it was determined that the amount of explosives in pounds required to fell a sound snag, using notches to contain the charge and without mudcapping, was the diameter squared and divided by 100. Thus, 25 pounds of C–2 or C–3 were

required for a 50-inch d. b. h. snag. Where mudcapping was used the charge could be reduced 20 percent. There was no advantage in using two notches with or without mudcapping. A clean shear was not obtained with this method. Frequently slivers up to 8 feet were left on the stump. Direction of fall could not be controlled.

(b) It was found that C–2 or C–3 was no more effective than a commercial 40 percent ammonia dynamite. A disadvantage was the time consumed in loading the 1⅛-inch bore holes. It was necessary to mold small pellets or rolls from the block of C–2 or C–3 to permit loading the hole.

(c) Tetrytol Demolition Chain wrapped around the exterior of a snag was successful up to 36 inches d. b. h. and a clean shear was obtained. This is a very fast method of felling a snag of this size and smaller. However, the amount of explosives used is considerably greater than required in the notching method, and it is exceptionally bad for setting fires.

(d) Shaped charges were tested to determine depth of penetration horizontally and for a means of quickly putting in a hole for loading and felling a snag with an internal charge. Several experimental shots were tried and finally a 15-pound charge was placed on the side of a 76-inch d. b. h. snag. The result was a hole entirely through the snag, 4 inches in diameter at the charge end and 1½ inches on the opposite side. The hole was loaded with a charge of C–3 computed to be sufficient to fell it. This failed, and it was subsequently felled with an overload of C–3.

Ten-pound and fifteen-pound charges were used to shoot holes through snags of varying diameters, which were left for a later test of final felling by the burning method. Results were not available at the time this article was written.

Paradoctor Appointed in Region 1.—Region 1 has completed arrangements for the service of Dr. Amos R. Little, former Army paradoctor, on emergency cases in inaccessible parts of the northern Rockies. The appointment of Dr. Little on a "when actually employed" basis marks an important forward step toward adequate protection against death from lack of immediate medical care in back-country accidents or other medical emergencies. The idea of parachuting civilian doctors originated with the late Dr. Leo P. Martin, of Missoula, Mont., who trained with the Forest Service smoke jumpers in 1941 and was killed in the crash of an Army plane a year later.

Dr. Little's preparation for this special work has been particularly applicable. He was sent to Missoula in the fall of 1943 as one of a party of 13 Army medical and training officers assigned for the purpose of training in Forest Service methods of parachute jumping. After training, Captain Little was assigned to search and rescue operations out of Casper, Wyo., and made several rescue jumps from that base. One highly successful rescue performed at 11,000 feet in the Colorado Rockies won him a medal as well as considerable repute as a skilled paradoctor.

During the summer of 1945 he was transferred to Great Falls, Mont., and his skill as a jumper was used successfully on several back-country accidents. Captain Little's services in these cases were in addition to his military search and rescue duties.

A graduate of Johns Hopkins Medical School, Dr. Little is now a practicing physician at Helena, Mont. The form of appointment and the nature of his duties in no way overlap or conflict with existing medical facilities available to the Forest Service, but add to its efforts to provide the maximum in medical service for its widely scattered field employees.

INFORMATION FOR CONTRIBUTORS

It is requested that all contributions be submitted in duplicate, typed double space, and with no paragraphs breaking over to the next page.

The title of the article should be typed in capitals at the top of the first page, and immediately underneath it should appear the author's name, position, and unit.

Any introductory or explanatory information should not be included in the body of the article, but should be stated in the letter of transmittal.

Illustrations, whether drawings or photographs, should have clear detail and tell a story. Only glossy prints are acceptable. Legends for illustrations should be typed on a strip of paper attached to illustrations with rubber cement. All diagrams should be drawn with the type page proportions in mind, and lettered so as to permit reduction. In mailing, illustrations should be placed between cardboards held together with rubber bands. *Paper clips should never be used.*

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The approximate position that illustrations bear to the printed text should be indicated in the manuscript. This position is usually following the first reference to the illustration.

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Wind River

FIRE CONTROL NOTES

A PERIODICAL DEVOTED TO THE TECHNIQUE OF FOREST FIRE CONTROL

FOREST SERVICE • U. S. DEPARTMENT OF AGRICULTURE

FORESTRY cannot restore the American heritage of natural resources if the appalling wastage by fire continues. This publication will serve as a channel through which creative developments in management and techniques may be communicated to and from every worker in the field of forest fire control.

Volume 8 Numbers 2 and 3

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A Quarterly Periodical Devoted to the

TECHNIQUE OF FOREST FIRE CONTROL

The value of this publication will be determined by what Federal, State, and other public agencies, and private companies and individuals contribute out of their experience and research. The types of articles and notes that will be published will deal with fire research or fire control management: Theory, relationships, prevention, equipment, detection, communication, transportation, cooperation, planning, organization, training, fire-fighting, methods of reporting, and statistical systems. Space limitations require that articles be kept as brief as the nature of the subject matter will permit.

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Forest Service, Washington, D. C.

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Contents

FIRE CONTROL IN RESOURCE MANAGEMENT

A. A. Brown

Assistant Chief, Division of Fire Control, U. S. Forest Service

Some observers at the recent Forest Congress were impressed by the undue degree to which we have separated protection of our forest resources from fire, insects, and diseases from the other management phases of the job. Others have felt that there is a conflict in some of our present conceptions. This question is highly important to the proper balance of effort in our Land Management job as well as to the continued sound progress of the protection phases of the job. Some stock taking seems in order.

The methods, policies, and traditions of modern forest-fire control began in the West. They strongly reflect the influence of huge areas of back country and of unmanaged, abused or extensively managed forest areas. The fire problem in such country is big. Men are often pitted against great forces of nature and are challenged to increase their stature figuratively to contend with them. So the conflagration fire involving many thousands of acres and the periodic threat of complete disaster tend to dominate thinking and planning.

The bigness and the challenge of such problems have contributed much to the quality and resourcefulness of Forest Service personnel from the start. In popular fancy, and even among the ranks of foresters, this kind of fire control has impressed itself as the whole of the job. It has been an easy step from this conception to the belief that forest fire control when fully perfected can consist everywhere of a specialized protection service to be provided by technicians, like a fire chief and his crew in a big city. With that done the householder can go happily about his other affairs and simply buzz twice if he needs a fireman.

A good many silviculturists and other resource specialists and even some administrators now take this view, and see no reason to concern themselves with fire control. Perhaps the highly developed technical phases of the fire control job and the specialized equipment which have rapidly evolved have contributed to this viewpoint. Such things encourage the comforting belief that it is a specialist's job and the responsibility could very well be disposed of by "contracting" for the job on a routine basis. This kind of thinking ignores the intimate relationship both between fire and the existing forest and between fire and the job to be accomplished.

Fire, for the most part, was the eventual harvester of the timber crop in the virgin forest. Allied with storm, flood, insects, or disease, it removed the old and started the new. Such old relationships are faithfully reflected by the characteristics and prevalence of many of our most valuable species. When man became the harvester, these old relationships were disturbed. The immediate effect was to greatly in-

crease the occurrence and effect of fire. The combined effect of fire and man's harvesting activities produced consequences which made the control of fire essential to stability.

Most present day forest units have a fire history reflecting these disturbed relationships. Over whole regions, fire in the recent past has determined the condition and present value of the forest resource. It has been decisive too in determining the productivity of forest sites and in the selection of species that now prevail. In turn, fire history has limited and continues to affect the whole social and economic pattern of the region concerned.

As fire-control measures become more efficient the significance of fire to the forest seems less important. But success only in reducing the areas burned each year does not relegate such things to the past. Fire has such varied effects under different conditions that simple exclusion may not be enough to enable skillful silvicultural or other management. There is increasing evidence that advanced practice is likely to call for some use of fire as a tool of management in order to then reestablish some of nature's old relationships. The forest manager must understand these relationships to his forest before he can manage it successfully.

Several principles are involved in relation to his over-all job.

In extensive management of wild land, fire has to be controlled. Alone, that is a sufficient basis for building extensive systems of fire control and for judging results only in terms of percent of protected area disturbed by fire in any given period. No fine distinctions are needed in an aggressive policy of controlling fires that start. The necessity of preventing man-made fires has also been generally accepted. On such premises our forest fire control policy and progress have been built. It has been patterned to the problem of holding down heavy fire losses on extensively managed or badly managed areas of wild land. In such areas, existing fire risks and fire hazards had to be accepted as a part of the fixed problem and the organization and methods had to be designed to fit.

Now that intensive management of a rapidly increasing portion of timber, range, wildlife, and watershed lands is becoming a fact, some changes in the manager's relationship need to be recognized. On really intensively managed areas, the magnitude of the fire job is no longer fixed. Methods within the manager's control can eliminate the old threat of complete disaster and can even cut down the size of the job so that his management organization can handle it. This process is never concerned solely with fire. It is less spectacular but more realistic than the alternative of building an independent fire organization capable of meeting the worst that nature and management together can produce.

Forest fuels are the most important factor in this relationship. The amount of fuel that is allowed to accumulate and its continuity are recognized by fire control men everywhere as fundamental in determining the cost of effective fire control and in fixing the losses that are bound to occur over a period of years. Lack of utilization of wood on the ground has always created the worst fire liability. Anyone who recalls the great mass of fire-killed debris in the Northwest following the 1910 burns or who has seen the Tillamook burn does

not have to be reminded that great areas of such debris set the stage for conflagration fires. Good management of timberlands will not allow such hazards to persist.

Similarly, traditional methods of clear cutting of Douglas fir in the Northwest create unmanageable fire hazards so long as great masses of wood representing vast storehouses of heat energy ready for the fuse are permitted. Wasteful clear-cutting of mature hardwoods and the great volume of dry fuel left behind have in the past created abnormal fire hazards in the Northeastern and Lake States. Similarly great open clear-cut areas fully exposed to sun and wind, even where natural forest fuels are light, create unnatural or unnecessary special hazards.

Some recent thinking has confused these relationships. The term "custodial" has been applied to the extensive type of management in which activities are restricted to protecting the area and building improvements. Such management was set off as the opposite to the ideal of a fully managed forest area. In promoting progress toward such an ideal, there has been a tendency to discredit the former as a part of the pioneering state which has now passed. In that process forest fire control became identified as part of the custodial job and even labeled as "custodial" in nature.

It is unfortunate that fire cannot be neatly catalogued as a "forest resource" in the effort to get foresters to give more thought to on-the-ground management, but protection enters so strongly into every phase and responsibility of that management that it has long been accepted as the first step.

Fire liabilities and probable losses depend in part on management practices on the ground and human risks and incendiary motives are apt to reflect administrative policies. The responsibility for successful results cannot for such reasons be closely confined to a small specialist group. Every forester of necessity must be something of a fireman. Undue emphasis on the operation or engineering phases of fire activities reduce this feeling of responsibility and in the long run tend to narrow the field of activity and opportunity of the forester.

Certainly "resource management" independent of any responsibility for active protection is hardly worthy of the name. If a distinction between degrees of extensive and intensive operation and management does need to be made it needs also to be applied to the practice of forest fire control. There is a pressing need to fully develop what may be termed "intensive management fire control." The status of the area manager is directly concerned. He cannot very well pass this responsibility to someone else if he aspires to be the real manager of resources on his unit.

The measures identified with intensive timber management which can reduce the fire potential that must otherwise be accepted in extensively managed areas, consist of good accessibility, small management units, close utilization, selective cutting where practicable, control of insect and disease epidemics, and some use of controlled fire. Comparable measures in raising the level of management of some other forest resources can also exert a profound effect. Increased employment of forest workers is also a characteristic of intensive management. Most of the employees, who under old methods had to

be recruited and employed for fire control duties only, then become available within the area. In such ways the size of the fire job itself and the means of dealing with it then come progressively within direct control of the manager. To the degree this occurs, the chances taken and the losses that result become his direct responsibility. Insect and disease losses have a similar relationship.

In exercising "intensive management fire control" or "intensive management protection," skillful use of fire becomes an appropriate tool of management subject also to close control and adaptable to many purposes. The use of fire to reduce the amount of hazardous fuel following timber cutting is an early tradition of the Forest Service. Methods and costs in excess of the risk involved properly brought the practice of piling and burning slash into disrepute under many conditions. Under intensive management no fixed formula will serve. Intensive utilization and selective cutting will drastically reduce the need of such measures. But where they are needed, cost limitations become less exacting.

But use of fire only to reduce fire hazards is self-limited. No extensive burning of a forest area for the sole purpose of hazard reduction can be justified under intensive management. Such large scale operations must have positive value in promotiing other purposes of resource management as well. The degree to which "prescribed" burning can or should be utilized for seedbed preparation, control of diseases, control of tree species, etc., is as yet only partially explored in most forest regions. It represents a field requiring the best talents and joint effort of both the silviculturist and the fire control specialist. The term implies intensive management.

For an indefinite period ahead the powerful challenge of the big fire and of the heroic measures it calls for, will continue to characterize the more extensively managed forest areas. All successful measures so far developed and many more will need to be pressed into service to meet it successfully. It justifies much specialization. But the rapid expansion of intensive management brings new and more intimate relationships between fire control and the rest of the management job. Both fire control men and resource managers will do well to recognize these new relationships and to join forces in advancing "intensive management protection."

FIRE CONTROL LOGISTICS

Frank J. Jefferson

Assistant Regional Forester, Region 5, U. S. Forest Service

In military circles logistics is defined as that branch of the military art which embraces the details of the transport, quartering, equipping, and supply of troops in military operations. This holds true whether the undertaking be on land, air, or sea.

Fire control logistics requires the same undertakings but may be more simply defined as the art of delivering manpower and matériel already planned for in the right quantities in the right places at the right time. Failure in any one of these elements simply means that all the high-powered knowledge of strategy, of fire behavior, etc., that may be brought to bear upon a fire suppression problem by the highest ranking brass hat in any Fire Control Service will come to naught unless someone somehow accomplishes all the essentials to consummate his plan. The fire boss calculates that with thus of men, this of tractors, and that of tankers he can control the fire on this ridge. But it is not going to end a fire at a planned time unless that part of the organization responsible for accomplishment of logistics puts the essential elements for control at the spot designated at the time and in the quantity prescribed by the fire boss. The fire boss, however talented, is at the mercy of the practical application of logistics to the problem with which he is faced. It is the quality of applied service of supply or logistics that determines whether we get a fire in its early stages, have an extra period fire, or have one of those monstrosities that hangs on for days until finally strangled by the weather or its own gyrations.

In military circles the art of logistics ranks high in the training of every officer; months are spent on indoctrination in its intricacies. Officers are drilled, drilled, and redrilled in what constitutes the numerical human components of a squad, company, regiment or corps and what the essentials to the movement, equipping, and operational sustenance of each unit are. Minute details such as the number of watches and compasses that are essential per unit are calculated. Map requirements are similarly closely calculated. It is important that every officer responsible for logistical action understands completely how many trucks are required and how many men are needed to load and unload them for a given movement within a given time for each unit of command, and what the command requires in the way of field equipment, mess equipment, rifles, revolvers, and other implements of war. He must also understand what the attritions of war action calculably are, and that he make provision for current replacement to offset this attrition. The problems in this field are materially different between ground, sea, and air forces; in fact, so different in some respects as to be almost opposites.

We in the Forest Service must deal with all three; primarily, ground requirements; secondarily, air—which in some quarters is crowding close to the ground requirements in volume; and, thirdly, sea, as exemplified by the Lake States situation, actions on Lake Chelan, Coeur d'Alene, Pend Oreille, and Mount Shasta. We have not yet, however, sufficiently comprehended the sharp differentiations that exist in the logistical technics applicable to the three methods of transport. In the cataloguing of matériel and manpower required for an attack under each of the three methods of approach we have progressed. In training of men in the technics of logistics we have done practically nothing. We still largely depend upon pinch hitters for chiefs of staff and, practically, pretty much still follow the tradition of early days when somebody said, "Hey, Bill, there's a fire on Sauerkraut Ridge," and Bill proceeded to round up all available men, shovels, axes, and hoedags and headed them toward the fire. This is admittedly somewhat of an exaggeration because we have developed to a point where we recognize the No. 0 ladies' shovel as a more effective fire-fighting tool than a No. 2 shovel and far more effective than a square-pointed D-handled scoop shovel. But more important (and granting that fires can be put out with scoop shovels) we have not yet made a dent in the art of getting the right things in the right quantities in the right places at the right time.

The fire boss contemplates use of an RD-7 angledozer or power-operated plow. Due partly to lack of equipment, more often due to lack of ingenuity in the art of substitution, the desired machine power arrives hours too late to fit his plan. Manpower desired by the fire boss at a given time arrives hours later than contemplated, because somebody lacked the courage to say, "Boss, we appreciate your desire but it just ain't attainable within your timing. Will you please refigure how many men and angledozers you would like to have 7 hours later." Delivery of manpower, supplies, and equipment is often delayed because someone failed to realize just how many pieces of transportation equipment would be required and at what time in order to attain the desired time objective. Break-downs and resultant delays occur because someone failed to appreciate the simple fact that with a given amount of transport equipment there is an inevitable percentage of failure. If the objective is to be attained, adequate swing equipment must be on the spot to offset these initial break-downs. With line equipment such as angledozers and tank trucks this failure to calculate probabilities exists, and jobs are planned with no consideration for the equipment break-downs inherent in the operation. Fire lines are lost because the one angledozer provided broke down. Sound application of logistics would have assigned at least two, and perhaps three, to the job. Men are walked energy-destroying miles when simple consideration of the logistical requirements dictated establishment of pack-train camps or perhaps man-pack camps to insure that all the potential energy of the crew was expended upon fire control effort and not uselessly frittered away on walking forth and back to trucks and thereby wasting the most effective hours of the day.

In many respects the application of the art of logistics by the back-country fire fighter of 40 years ago was far superior to the general practice of today. He knew that his fire was in tough country, that

he would have a hard time getting to it, and that he would have to do his best with the little he could bring to it. Consequently, his application of logistics summed down to the simple matter of how he could get to the fire the most effective supplies, equipment, and manpower with the few mules available. Today in an era of rubber and gas, with countless trucks and the hope, however fruitless, of more and more trucks and more and more men we have practically lost the art of simplicity in organizing for and executing fire control actions. Our thinking and procedure have become complex and often bog down under their own weight, predicated too often upon the mass movement of hundreds of men and tons of supplies to the nearest point within road distance of a fire. What happens from then on is in the lap of the gods. If the fire stays close to the road, well and good; if it reaches into the hinterland, a catastrophe may result if our application of the art of logistics does not apply all of the technics available in the fields of air, water, truck, mule, and man-back transportation. Yet we do not give men the benefit of planned training in this art.

We watch the clock too closely in determining when shifts should start (6 o'clock breakfast) and fail to appreciate that victory is gained by taking the enemy when he is weak; the important point of having the right forces in the right places at the right time and in the right quantities. We fuss because we cannot have men and supplies at the time that we would like to have them, failing to appreciate that the first element of the fire boss job is to realize just what the availability of these resources is and to plan and replan control action in accordance with these facts, which the logistician must deliver to him coldly and dependably.

This is a brief summation of the elements in the science of applied logistics for which chiefs of staff and others with similar duties have a most important responsibility. It is up to them to know the possibilities of procurement of all the various implements of fire control desired by the fire boss and keep him honestly apprised as to the time that their placement upon the fire line may be positively expected. It is the job of the logistician to give the fire boss the facts about the essentials and thus give him ample opportunity to prepare plans based upon these facts. Altogether too many fires are not controlled within the planned time limits. In the main this failure is much more due to ignoring or not realizing the import of the logistical facts in the situation than to the acts of God in the form of wind, behavior, etc., that are all too frequently blamed.

732984—47——2

MOBILE 25-MAN OUTFIT

John B. Fortin
District Forest Ranger, Ouachita National Forest, U. S. Forest Service

The desirability of a mobile 25-man outfit had been recognized on this forest for several years. Specifically, the features wanted in such an outfit were as follows: (1) Compactness to permit mounting on a standard long base stake-body truck, (2) complete cache of hand tools for 25 or more men, (3) facilities for cooking and serving meals in the field, as close to the fire as possible, (4) emergency rations, (5) communication facilities, (6) water tank, pump, and hose. This need was finally filled during the very dry and hazardous spring of 1943 by attaching 2 fire boxes and a pump and tank assembly to a stake-body truck.

The tank has a capacity of 165 gallons. On it is mounted a live reel with 500 feet of ¾-inch garden hose. At first a hand force pump was used, but this was later removed and a Panama pump with power take-off was installed under the truck cab. A drain on the tank permits filling backpack pumps when other water is not available. This is a very desirable feature in areas where streams go dry during certain periods of the year and water must be hauled to the fire. A 25-foot, noncollapsible intake hose is used for filling the tank.

The contents of the two fire boxes are as follows:

Box No. 1

4 double bit axes.	2 hazel hoes.	8 files.
2 brush hooks.	2 mattocks.	1 camp cook stove.
24 council tools.	4 timber carriers.	2 gallons kerosene.
2 crosscut saws.	4 potato hooks.	2 first-aid kits.
6 canteens.	2 shovels.	6 seals.
	Pencils, time slips, map, signs	

Box No. 2

4 backpack pumps.	1 roll-top table.	1 portable radio.
6 lanterns, kerosene.	1 fly, tarpaulin.	1 roll (½ mile) emergency telephone wire
4 lanterns, gasoline.	25 K rations.	2 wrenches, adjustable.
2 electric headlamps.	25 canned rations for cooking.	1 each pliers, hammer, hand saw.
1 knapsack.	1 100-foot rope.	
8 canvas buckets.	1 portable telephone.	
1 mess outfit, 12-man.		

The roll-top table listed in box No. 2 consists of slats of ½ by 1½ by 38 inches to which has been tacked light canvas or other suitable fabric. When rolled out on the ground or on supports, it provides a clean surface on which to serve meals. Because of its roll-up feature, it occupies comparatively little space in the firebox.

Many of the fires on this forest are close to traveled roads or logging roads which give access by truck to at least part of the fire line. This permits placing the crews close to the fire with a minimum of foot travel and feeding them there.

During a period of long drought, a fire occurred on September 17, 1943, in an area of heavy slash on the Mena District. A strong wind blew sparks as much as 150 yards causing spot fires in the dry duff. The ranger had a choice of trying to hold the fire on a very poor logging road at the foot of a slope or falling back to the top of a ridge. He determined to hold the fire at the logging road. The hose and pumper were brought into play to cool the fire as it approached the road so that a line could be built. The numerous spot fires caused by sparks jumping the road were extinguished quickly with the hose. Without the aid of this mobile outfit the fire could never have been held along the rudimentary road. What could have very easily been a 500-acre fire was held to 60 acres. The men were fed right at the fire line with food stocked in the truck cache.

Arrangement of tank, hose reel, and boxes of 25-man outfit. Tailgates are used when truck is in motion.

Another typical fire on which this outfit proved its usefulness occurred on August 20, 1944, on the Mena District. Fuel moisture was down to 4.1 percent and a fresh wind was blowing when a fire was reported in an area of heavy slash and high grass. Only 12 men were available for immediate dispatch. When the crew arrived at the fire it found that an old overgrown logging road paralleled part of the head and one side of the fire. The crew was too small to split into 2 parties because of the intensity of the fire. One hoseman and the truck driver managed to hold part of the head and the side of the fire along the logging road. This permitted the remaining 11 men to be used in force where the truck could not maneuver. Without the truck, the ranger figured he would have lost at least 300 acres. Actual loss was 60 acres.

Other instances have proved conclusively the usefulness and versatility of this equipment since it was first assembled, with the result that similar units have been provided for the other districts on this forest.

A DUAL PURPOSE HAZARD REDUCTION BURNER AND FOAM UNIT

A. B. Everts

Forester, Snoqualmie National Forest, U. S. Forest Service

Hazard Reduction Burner

Many fire control officers are familiar with the hand pump, air-pressured Hauck torch. When working properly the Hauck is a good torch. The principal difficulties are its rapid loss of pressure, which makes frequent pumping necessary, and the clogging of the small discharge orifice.

Believing that the employment of an improved burner and a method of maintaining constant pressure would overcome these faults, the men of the Snoqualmie National Forest constructed an automatic unit.

A 40-gallon, 185-pound test galvanized high-pressure hot-water tank was purchased and hooked up as shown. Nitrogen, an inert gas, was used for pressure. The pressure in the nitrogen tank (2,000 pounds) was reduced to an operating pressure of 35 pounds by the use of a reduction valve. An 80-foot length of ½-inch hose was connected to the burner, a KER-O-KIL model No. 44. This burner, like the Hauck, requires preheating before it will generate properly. The kerosene burns at 2,000° F. and produces a flame 24 by 44 inches. According to the manufacturer, the burner consumes 2 gallons of kerosene per hour. Our tests, however, indicated 1½ gallons per hour as being more nearly correct.

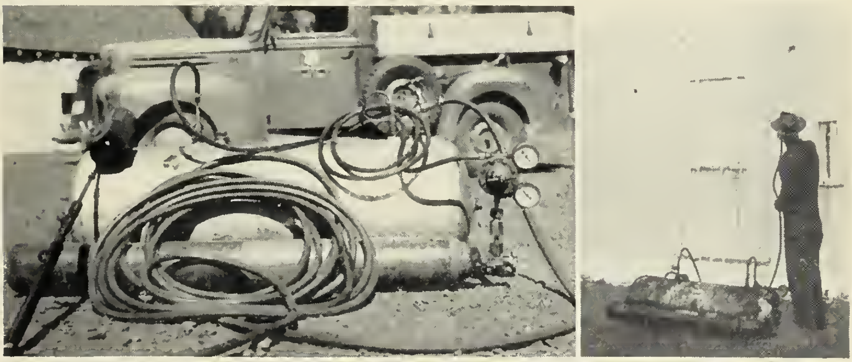
Loaded on a pick-up, or, better yet, a 4 by 4, the unit can be used on most pine operations. It is of value on roadside hazard reduction in the Douglas-fir type. The unit was used hour after hour on slash disposal last fall without any clogging or other difficulties. According to our figures, one 40-gallon tank of kerosene will serve the burner for approximately 60 hours. One cylinder of nitrogen will furnish sufficient pressure to expel three 40-gallon tanks, or 120 gallons total. The cost of recharging the nitrogen cylinder here in Seattle is $1. Thus, the operation cost is less than ½ cent per hour for the nitrogen.

Because of the low rate of fuel consumption, friction loss is negligible. If a burning unit only is desired, a standard 85-pound test tank is sufficient. A 20-gallon tank would operate for approximately 30 hours. In our work the larger, heavier tank was used, however, so the unit could be used for foam during the fire season.

A Foam Unit

In using foam, much higher tank pressures are needed. The friction loss in small hose is high, and to produce good foam, nozzle pressures of 30 to 100 pounds are necessary, with the foam quality increasing at the higher pressures.

The two types of foam in use today are chemical and mechanical. Chemical foam is a powder. The equipment for its use is rather complicated and will not be discussed here. Mechanical foam is a liquid and can be premixed with water at the rate of 6 gallons of solution to 94 of water. A specially designed foam nozzle must be used. This nozzle sets up a whirling motion of the water and foam solution which picks up air at the back end of the nozzle and produces foam. Foam nozzles come in sizes from the small plastic type, used on this unit, to 2½-inch sizes, producing 1,200 gallons or more of foam a minute. At 100 pounds nozzle pressure, a foam and water mixture will produce about 10 times the capacity of the container. That is, a 500-gallon tank truck with a 6 percent liquid foam solution will produce approximately 5,000 gallons of foam.



Left, nitrogen-pressured kerosene-burning hazard reduction unit. Right, the unit converted to foam. The foam clings, smothering the fire and preventing reignition.

In theory, foam is best for oil and gasoline fires since it can be applied quickly in large quantities, blanketing out the oxygen and smothering the flames. Its use on forest fires needs to be more thoroughly tested. David P. Godwin reported on its use in Aerial and Chemical Aids, Fire Control Notes, December 1936. Improved methods of handling foam have been devised since then. The writer is of the opinion that foam has a place in forest fire fighting, especially in the light fuel areas, mainly because of its volume increase. Is 5,000 gallons of foam more effective than 500 gallons of water? If so, how much? These are questions needing an answer.

On account of its cost, foam should not be premixed in the tank truck because then it has to be used. A method of quickly forcing the foam liquid into the tank when needed can be simply devised. Foam prices are quoted all the way from $10 to $25 per 5-gallon can. It has been sold on surplus sales for as low as $1 per can.

Foam has one quality that cannot be overlooked; that is, its clinging characteristic. It can be applied to a wall or other part of a building and it will cling for several hours. The value of this property can best be realized by quoting from The Use of Fog and Foam by Small Fire Departments, by Walter W. Stephen, in the January 1946 issue of Fire Engineering. This article states:

A hose and chemical truck from an industrial plant went 4 miles out into the country to a cross-roads community in response to a phone call. It was found

that a fire, starting at one end of a row of five small one-story, frame, shingle-roofed dwellings, had involved two, and seemed certain to destroy all of them. There was no source of water, nor any apparent way to fight the fire.

There was, on this piece of apparatus, a 40-gallon foam extinguisher. This was operated, and covered the exposed side and half of the roof of the third house with foam; these surfaces were scorching and smoking and about to "light off." The blanket of foam remained in place and protected and saved this house and the other two dwellings beyond it, while the first two that were on fire burned to the ground. The point about this case is that it was a peculiar and unusual one of the use of foam on a class I fire.

The operating data on the unit as shown is as follows: 2½ gallons of liquid foam solution was poured into the tank and the rest of the tank filled with water and recapped. A small, plastic foam nozzle was substituted for the burner. Pressure was increased to 125 pounds. The foam produced was measured out in 30-gallon garbage cans. The unit operated for 22 minutes and produced 370 gallons of foam. This is at the rate of better than 16.8 gallons of foam per minute with the water consumption at slightly under 2 gallons per minute. There is little mechanically that can go wrong; no pumps or motors; no moving parts. Such a unit, mounted in a pick-up or 4 by 4 should work out well on light fuels.

If nitrogen is difficult to secure, other pressure mediums can be used. Carbon dioxide can provide pressure for the foam unit. It will not operate the burner, however, because so much of the carbon dioxide is absorbed into the kerosene that the mixture will not burn. Compressed air should work with either the burner or the foam. Oxygen should never be used. It is dangerous when used with oil of any kind.

Caught—Three Firebugs.—"On Jakes Branch, Ranger, and looks like 2 sets," the Pilot Mountain lookout reported to the Pisgah Ranger at 9:05 p. m. on April 14, 1946. At 9:10 p. m. the lookout reported 2 more fires and at 9:15 p. m. another 2. In all a total of 10 fires were set over a distance of 4 miles. Crews quickly suppressed the fires and the damage caused by all of them was small, but the fact that firebugs were loose in the woods during a period of high fire danger caused considerable apprehension.

By 1 p. m. on April 15, the ranger had called all crews in from the field to stand by at the depot. At 2:15 p. m. the Pilot Mountain lookout reported 2 fires set on the Rosman Road, and at 2:25 p. m. 2 more; over a distance of 10 miles a total of 8 fires were set along this road. Again quick suppression kept the fires small. At 7 p. m. 2 more fires were set along the Rosman Road, and at 9:15 p. m. 2 more fires were set in the Jakes Branch area. The last 2 burned 8 acres. The 22 fires burned 30 acres of National Forest land, and suppression costs amounted to $198.

But the fire setters, whom we will call X, Y, and Z, had been careless. It was found that X's car had been identified on Jakes Branch on April 14, and that Y and his car had been identified near the fires on April 15. The ranger sent for the F. B. I. On April 16 Agent Ingram and the Pisgah Ranger questioned the drivers of the extractwood trucks along the Rosman Road and received the following signed statements:

First driver: "I passed Y and Z near Alligator Rock and just above where I passed them was a small fire which me and my helper put out."

The helper: "I was with the first driver when we passed Y and helped fit the fire, but I was a deserter and have a dishonorable discharge from the Army so what I seed ain't no good."

Second driver: "I passed Y and Z at 6:30 p. m. on April 15, and then passed two fires that had just been set."

Third driver: "I passed Y and Z about 6:15 p. m. and they were out of their car, which was parked alongside the road. When I came past this same place next morning, I found a fire had been set at this spot."

(*Continued on p. 21*)

KILLING BRUSH WITH 2,4-D

ROBERT K. BLANCHARD

Forester,[1] *California Forest and Range Experiment Station*[2]

2,4–D is a member of the group of new wonder chemicals which includes DDT, penicillin, and the sulfa drugs. They all have remarkable powers to kill specific organisms which are either harmful or troublesome to mankind, but they all have their limitations. Certain serious diseases are cured by the drugs as if by magic. With DDT flies can be driven from their favorite habitats, and dandelions wither and die if sprayed with 2,4–D. But people still die of infectious diseases, we still have hords of insects, and we can safely predict that we will continue to have troublesome weeds and brush.

2,4–D is the abbreviated name of a chemical compound called 2,4–dichlorophenoxyacetic acid, but the pure acid is not much used in practice because it is only slightly soluble in water. Instead, more soluble compounds are prepared with the acid, and for a given content of the parent acid they appear to be equally effective.

The most outstanding properties of 2,4–D are its toxicity in very small quantities and the fact that the chemical stimulus moves downward in the plant along with food manufactured in the leaves. Mustard seedlings in grain fields can be killed with as little as a pound of 2,4–D per acre without affecting the grain. 2,4–D is noninflammable, noncorrosive to equipment, and is nonpoisonous to animals; but the oil solutions may irritate the skin of some individuals. In addition, it is easy to handle and use as compared with certain other herbicides, and it does not deteriorate under normal storage conditions.

Just why 2,4–D is so poisonous to plants and why it kills some plants and not others is a mystery. A few days after susceptible herbaceous plants are treated with 2,4–D, the leaves and stems twist and curl. In a few more days the stems and even the roots swell and split as a result of the abnormal growth. In about a month the plants are usually dead. Only a few woody plants show these so-called formative effects to any extent.

2,4–D does have a sterilizing effect on soil regardless of statements to the contrary which appear on the labels of some products. It is only temporary, however, for the chemical is effectively leached out by a few inches of rain.

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[1] Acknowledgment is made to L. P. Winslow of the Blister Rust Investigations office at Berkeley, Calif., who conducted the fall field tests and to H. R. Offord, in charge of that office, for his hearty cooperation on this project

[2] Maintained by the Forest Service, U. S. Department of Agriculture, in cooperation with the University of California, at Berkeley, Calif.

Experimental Work

In view of these remarkable properties of 2,4–D, the Experiment Station in the fall of 1945 undertook a study of the effect of 2,4–D on the brush species of California. The purpose of the initial phase of the experimental work was to determine over a representative geographical range what species of brush can be killed by 2,4–D. One or more test sites was selected on the Angeles, San Bernardino, Sierra, Eldorado, Lassen, Shasta, and Klamath National Forests to include about 40 kinds of brush. The work was started in the fall of 1945 and was continued after the start of new growth in the spring of 1946. Application of the spray was made by square-rod plots at the rate of 10 gallons per square rod. The sodium salt of 2,4–D was used in concentrations of 0.04, 0.08, and 0.12 percent acid. The spray equipment consisted of a tank truck equipped with a power take-off pump. A pressure of 100 to 125 pounds was used with a No. 5 disk nozzle which gave a rate of delivery of about 1 gallon per minute.

The results of the fall work were poor because the brush was then in a state of dormancy. The spring spraying killed the leaves of most species treated. Even in the case of those classed as resistant, the succulent growth of the current season was killed regardless of the stage of development. Some nonsprouters were killed outright, but the sprouters sent out suckers from the crowns and the bases of the stems. In no case was a 100-percent kill of foliage obtained.

Table 1 is a list of species with common and scientific names giving the susceptibility of each to 2,4–D as indicated by the tests conducted in May and June 1946. High susceptibility means that 80 percent or more of the leaves were killed by the strongest spray although in some cases the stems were still green 3 months after treatment. Resistant species are those in which the old leaves were not affected by the treatment. Those of moderate susceptibility lie somewhere between these limits.

TABLE 1.—*Susceptibility of the foliage of California brush species to 2,4-D*

SPECIES	SUSCEPTIBILITY to 2,4–D
Adenostoma fasciculatum (greasewood or chamise)	High.
Aesculus californica (California buckeye)	Do.
Amorpha californica (California amorpha or mock locust)	Resistant.
Arbutus menziesi (Pacific madrone)	High.
Arctostaphylos patula (greenleaf manzanita)	Moderate.
A. viscida (whiteleaf manzanita) [1]	High.
Artemisia arbuscula (low sagebrush) [1]	Do.
A. cana (silver sagebrush) [1]	Do.
A. tridentata (big sagebrush) [1]	Do.
Baccharis pilularis (kidneywort baccharis or coyote brush)	Do.
Castanopsis chrysophylla (giant evergreen chinquapin or golden chiquapin).	Resistant.
Ceanothus cordulatus (mountain whitethorn ceanothus)	High.
C. crassifolius (hoaryleaf ceanothus)	Do.
C. cuneatus (buckbrush ceanothus) [1]	Do.
C. divaricatus	Do.
C. integerrimus (deerbrush ceanothus)	Do.
C. prostratus (squawcarpet ceanothus)	Resistant.
C. velutinus (snowbrush ceanothus or tobacco brush)	Moderate.

TABLE 1.—*Susceptibility of the foliage of California brush species to 2,4-D*—Con.

SPECIES	SUSCEPTIBILITY to 2,4-D
Chamaebatia foliolosa (bearmat)	High.
Cytisus scoparius (Scotch broom)	Do.
Eriodictyon californicum (California yerbasanta)	Do.
Garrya sp. (silktassel or quinine brush)	Do.
Lithocarpus densiflora (Tanoak)	Do.
Pachistima myrsinites (myrtle or Oregon boxwood)	Resistant.
Photinia arbutifolia (Christmasberry or toyon)	High.
Pinus ponderosa (ponderosa pine)	Moderate.
P. sabiniana (Digger pine)	Resistant.
Prunus emarginata (bitter cherry)	Do.
Pseudotsuga taxifolia (Douglas-fir)	Moderate.
Quercus chrysolepis (canyon live oak or maul oak)	Do.
Q. dumosa (California scrub oak)	High.
Q. kelloggii (California black oak)	Do.
Q. wislizeni (interior live oak)	Resistant.
Rhamnus californica (California buckthorn or coffee berry)	High.
Rhus diversiloba (Pacific poisonoak)	Do.
R. laurina (laurel sumac)	Do.
R. trilobata (skunkbush sumac or squaw bush)	Do.
Rubus ursinus vitifolius (grapeleaf California dewberry)	Resistant.
Salix sp. (willow)	High.
Sambucus glauca (blueberry elder)	Do.
Umbellularia californica (California laurel or bay)	Moderate.
Vitis californica (California grape or wild grape)	High.

[1] Nonsprouters which were killed.

The results obtained in this preliminary work are not satisfactory as an answer to the question, "Can brush be killed with 2,4-D?" They are nonetheless encouraging, for although all species sprouted, all individuals did not. Low California scrub oak (*Quercus dumosa*), for example, had only a few feeble sprouts 3 months after treatment with 0.12 percent spray. The problem resolves itself into one of finding out when, what, where, and how to treat.

The following recommendations are made on the basis of the work reported here and the work of other investigators in the East. It is along these lines that future work will be done at this Station.

Procedure for Treating Brush With 2,4-D

1. What to treat:

a. Sprouting species.—Spray only low growth (not over 3 feet high) or stumps. Higher brush should be chopped followed by treatment of the stumps. 2,4-D does not move downward effectively over distances in excess of 3 feet.

b. Nonsprouters.—Susceptible species of any size can be killed, but if the brush is high, chopping in the first place is probably a more satisfactory method of control. The best results have been obtained on brush 3 to 4 feet high because it is easier to spray thoroughly. Thorough spraying of tall brush is difficult to accomplish and expensive in labor and material.

2. How to treat:

a. Brush (sprouting or nonsprouting).—Thoroughly spray foliage with a water solution of 0.2 percent acid which is 2,000 parts per mil-

732984—47——3

lion. (See tables 2 and 3 for mixing solutions.) *Every Leaf Must Be Wet With Spray.* It is necessary to add a wetting agent to the spray so that the drops will not roll off the leaves. For small-scale work, "Vel," "Dreft," or "Swerl," nationally advertised soap substitutes, are satisfactory wetting agents when used at the rate of about 1 cupful to 5 gallons of spray.

b. Stumps.—Wet the freshly cut surfaces with 1.0 percent solution in kerosene using a 2,4-D ester (described below). Only kerosene should be used as a carrier because it is the least poisonous (of the regular petroleum products) to plants. If a toxic oil (virtually all petroleum products except kerosene) is used, the oil itself will quickly kill the conducting tissues and the 2,4-D will have little effect. For treating stumps in trail work, 10 percent kerosene solutions can be applied with a paint brush or a household fly sprayer. Very little is required, but the sapwood should be thoroughly treated.

3. When to treat:

a. Brush.—Brush must be treated while it is in full leaf and physiologically active. This is usually between the end of the flush of spring growth and early July. The best time is shortly after the end of the spring growth. Spray in a warm period when the daytime temperatures are above 70° F. and when the foliage is dry. Rain which occurs more than 6 hours after treatment will have little effect.

b. Stumps.—Stumps should be sprayed or painted immediately after cutting. If, however, some time has elapsed, the bark should be frilled all the way around with an axe and the chemical applied to these fresh cuts as well as to the old cut surface. The lower the stumps are cut, the better. The effective season for treating stumps is not known, but it probably extends from the beginning of the growing season to midsummer.

A certain amount of sprouting is to be expected after any chemical treatment of brush. Such sprouts should be given a follow-up treatment with water spray within a few weeks after they appear.

Commercial 2,4–D Preparations

2,4-D is manufactured in two general chemical forms, salts and esters. The salts (sodium, ammonium, and triethanolamine) are soluble in water. The esters (methyl, isopropyl, and butyl) are soluble in oil and are marketed in oil solutions containing emulsifying agents. They can therefore be used with either oil or water as a carrier.

The cost per pound of 2,4-D acid in the form of salts is about half as much as in the form of esters. The triethanolamine salt is the cheapest of all and is available in solutions containing 20- and 40-percent acid by weight. The other two salts are sold in the form of powders. One product contains 60 percent acid by weight, another, 77.5 percent. The 60 percent salt contains a wetting agent but in insufficient amount for glossy-leaved plants. The esters are all sold in liquid form. The methyl ester is available with 20 percent acid content by weight, the butyl ester with 32 percent. (The latter contains 40 percent of the ester compound.)

These products, except the isopropyl ester which is not yet available in commercial lots, are sold in wholesale quantities by the manu-

facturers and are generally available at chemical and spray material supply houses. An increasing number of preparations containing 2,4-D are also sold in seed and hardware stores under a variety of trade names.

Special wetting agents for spray work are available. They are all good but one should be sure that they can be used with 2,4-D. Some of those containing "stickers" gum up tank and spray equipment and are not recommended. "Tergitol" is a satisfactory product. Directions for use are given on the packages, but if the 2,4-D product already contains a wetting agent, less of the supplementary spreader should be used. Too much wetting agent causes excessive drip from the leaves and is therefore wasteful.

TABLE 2.—*Weight in ounces according to acid content of 2,4-D product required for 0.2 percent spray solutions* [1]

Volume (gallons)	Weight by 2,4-D acid content percents—				
	20	32	40	60	77.5
	Ounces	*Ounces*	*Ounces*	*Ounces*	*Ounces*
5	6.5	4.15	3.3	2.20	1.7
10	13	8.3	6.5	4.4	3.4
50	64	41.5	32	22	17
100	128	83	64	44	34

[1] For a 1-percent spray, use 5 times the weight listed for the desired volume.

TABLE 3.—*Approximate amount of 2,4-D liquid product required for mixing 0.2 percent spray solutions*

Volume (gallons)	2,4-D acid content	Cups of 2,4-D product	Volume (gallons)	2,4-D acid content	Cups of 2,4-D product
	Percent	*Number*		*Percent*	*Number*
6	20	1	6	40	½
5	32	½	7	[1] 60	½

[1] Powder form.

The recommendations made here are for the general guidance of field men who are planning limited experimental work. Practical ways in which 2,4-D can be applied to the general problem of brush-control cannot yet be well defined. Still to be determined are the concentrations and rates of application as well as the best season for treatment for each species. It is expected that spraying with concentrated solutions at a low volume rate per acre will prove cheapest, but this method requires special equipment. Some tests have been made by others on brush using 2,4-D as a dust, but the results have not been as good as with sprays.

In spite of the mediocre results obtained to date, the outlook for successfully controlling certain kinds of brush with 2,4-D is good. The Bureau of Entomology and Plant Quarantine has obtained very good results with certain species of *Ribes* and are planning to use considerable quantities of 2,4-D during the 1947 season for *Ribes* eradication work. The price of the chemical is an obstacle at present, but it is almost certain to go down as production increases.

REGION 6 EQUIPMENT DEVELOPMENT LABORATORY

Theodore P. Flynn

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The Equipment Development Laboratory at Portland, Oreg., had its start on October 4, 1935, when F. A. Silcox, then Chief of the Forest Service, approved a proposal by T. W. Norcross, Chief of the Division of Engineering, that suggestions for equipment improvement and development be referred to the Chief's office for consideration, and that approved projects of Service-wide benefit be financed.

The laboratory began work in 1937, under the supervision of the Regional Engineer in Portland. Concerned primarily with road construction and maintenance equipment, the work included testing, improving and developing equipment for fire control and other Forest Service work.

For several years, construction of models as well as design was done by laboratory engineers and mechanics. Later the laboratory personnel and equipment were moved to Sellwood, in south Portland, where the equipment repair shop is located. Construction work is now done by the shop mechanics, the laboratory development work being confined to design and testing. However, a section of the shop is devoted especially to work on laboratory projects.

Over the years the laboratory has built up a technical library, and it is on the mailing lists of a large number of firms, who contribute up-to-date material regularly, particularly on metallurgy and mechanical design. The library and the advice of laboratory engineers are, of course, available to departmental shop personnel and others.

Objectives of the laboratory are (1) to promote commercial manufacture of successfully developed items, so they will be available for purchase at lower prices by the Forest Service and others needing them; and (2) to contribute to the improvement of commercial equipment on the market, so that it will better meet the requirements of the job.

Problems encountered at the laboratory are of wide variety, relating to many kinds of equipment. Called the largest logging tractor in the world, a 46,500-pound giant popularly known as the "Tomcat" was designed, constructed, and put into successful operation by laboratory personnel. At the other extreme is the "Beetle" trail-tractor,[1] weighing less than 2,000 pounds, probably the smallest bulldozer-equipped full-crawler tractor ever constructed. In between is the larger trail tractor,[2] about 4,500 pounds, which was one of the earliest developments.

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[1] Fire Control Notes, July 1946, p. 1.
[2] Fire Control Notes, April 1940, p. 93.

Throughout a period of nine years, the laboratory has handled or taken part in over 300 development projects. Many, of course, were small items of local interest or need. The "batting average" on these projects has been high; only a little over 10 percent were failures because they did not meet requirements or failed to receive popular approval.

The largest manufacturer of crawler tractors in the country has adopted some of the principles of the "Tomcat" on a new test model now in the field. The "Beetle" is already in quantity production, with prospects of a much larger market outside than inside the Forest Service. And the Oliver Corp. is now in quantity production of a light tractor, patterned after the original trail tractor, which has sufficient ruggedness, power, and stability for fire line construction. There is considerable demand for the heavy-duty brush mower outside the Forest Service, but it is not yet being manufactured commercially, although a mining company in Alaska has constructed brush mowers for its own use from laboratory plans.

Rock blade development at the laboratory stimulated the production of a land-clearing blade now being manufactured and sold in large numbers. Laboratory engineers have also helped develop and improve power chain saws, now in wide use by loggers. Three of the most successful chain saw manufacturers made many of their early tests in the laboratory yard and were aided by suggestions from laboratory engineers.

During the war, the Army found two important laboratory developments valuable. When the need arose for a light, narrow tractor to be transported by airplane, Forest Service trail tractor plans and a model were quickly made available; the airborne tractor, known as the Clarkair, was soon in production and more than 8,000 were manufactured under Army contracts. The snow-tractor, developed for use on Mount Hood, was tested by the Army along with commercial makes, and a contract for similar snow-tractors was let to a Portland manufacturer.

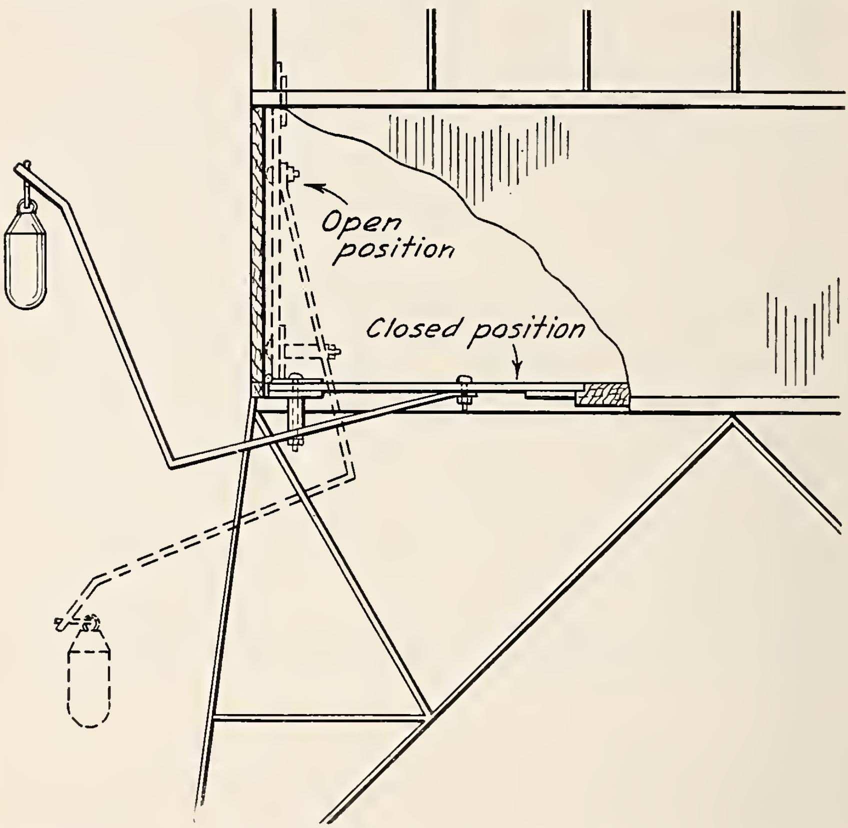
In addition to its work for the Divisions of Engineering, Fire Control, Timber Management, and Range Research during the past 2 years, the laboratory has been called upon for advice by foresters and loggers in various parts of the country. This service involves the writing of many advisory letters every year. Each development project must, of course, be financed by definite allotment of funds, but it is possible to furnish information and advice without cost if they do not involve work on the drafting board.

TOWER DOOR COUNTERWEIGHT

Favre L. Eaton

Assistant Supervisor, Helena National Forest, U. S. Forest Service

Opening the trap door in the floor of a lookout tower cab has been made easier and safer by the installation of a simple counterweight suspended on a side arm. Being able to open with one hand the



overhead door of a lookout cab 20 to 100 feet off the ground is a big help to a towerman, especially when carrying anything. The door will remain open or closed, as desired, when the counterweight is used.

Such a door opener was designed by Lookout Ralph F. Eaton, made in a local shop at a cost of $3, and installed in a few minutes. He used

an inverted 5-inch motor piston as a counterweight in order that extra weights could be placed inside the piston if any were needed. It is believed iron sash weights would prove the cheapest and best appearing weight.

The device consists of a rigid arm constructed of 2-inch angle iron welded at a 90° to 100° angle, one end bolted to the underside of the trap door, and the other end, on which the weight is fastened, extending upward and outward alongside the lookout cab. The horizontal iron bolted to the trap door is 2 feet in length, and the nearly vertical iron holding the weight is 3 feet long from angle to weight fastening. A window-sash weight of 8 or 10 pounds is fastened to the upright angle iron by the use of an eyebolt. For a very windy lookout, an additional angle iron should be welded to the arm near the angle formed by the horizontal and vertical irons, and bolted to the door as a side brace to offset vibration. Aluminum paint can be used to dress up the device and protect it against corrosion.

(*Continued from p. 12*)

The F. B. I. agent and Ranger then proceeded to the home of Z and in the presence of his father took down his sworn statement that he was with Y when Y set the fires on the 15th and that both X and Y had asked him to go with them and set fires on the night of the 14th. Further investigation found that another witness had identified X's car on April 14 as the only car that had passed where the fires were set.

On the 17th Federal warrants were taken for X and Y and both men were arrested and placed in jail. On the 18th trial was held before U. S. Commissioner Kizer in Brevard, N. C. Z could not be found, and the trial was postponed until May 3. Again Z could not be found and the trial was held without him. The Commissioner placed Y under $1,500 bond to appear before Federal Court in May. A true bill was obtained for X before the Federal grand jury, but at the May court Z again failed to appear. On May 18 after court adjourned Z came before Commissioner Kizer and said he had been "hid out" by X, Y, and a brother of theirs. The Commissioner took a signed statement and mailed it to the District Attorney.

An F. B. I. agent was sent out to arrest the three brothers for intimidating a Government witness. At the trial, Z denied everything he had said in his sworn statement, and the Commissioner dismissed the case. Again a true bill was obtained from the grand jury and the three brothers were charged with intimidating a Government witness. At the November term of Federal Court everybody but Z appeared; this time he was in Florida. The Government proceeded to call the case without him. However, X and Y were getting uneasy. A jail sentence looked almost certain for Y, and possibly for X, so their lawyer asked to plead Y guilty and take a nolle contendre for X, if the court would fine them $200 and place them on probation instead of sending them to jail. The District Attorney accepted this compromise and the case never came to trial. Y paid a $200 fine (cost of suppressing fires) and was given a 6 months' jail sentence suspended on 18 months' probation. X received the same sentence and probation. The third brother pleaded guilty to the charge of intimidation of a Government witness and was also given a 6 months' jail sentence suspended for 18 months.

Lawyer fees, fines, and the time spent fighting the charges in this case cost the brothers more than $1,000. The probation sentence should keep them well behaved for some time to come. Z still has to face a charge of perjury, as he denied the statement sworn to before the U. S. Commissioner. He also is liable for $1,000 bond for not appearing in Federal Court. The fact that a signed statement is not usable as evidence when denied by the witness under oath, caused considerable work in rebuilding the case, but this illustrates that justice can be obtained if a case is built up and fought regardless of adverse conditions.—BILL HUBER, *Ranger, Pisgah National Forest.*

A FOREST FIRE TRUCK

William H. Smith

District Forester, Pennsylvania Department of Forests and Waters

Forest District No. 14, which is also known as the Cornplanter Forest District, comprises the five northwestern counties of the Commonwealth of Pennsylvania, with headquarters in Warren. As the district does not contain any State forest land or parks, it is termed a forest protection district. For this reason the personnel assigned to the district are able to devote considerable time and effort toward the development of new protection ideas, techniques, and equipment. This article deals with the development and ultimate use of a forest fire truck of which the Department of Forests and Waters can be justly proud.

In the fall of 1942 a ½-ton pick-up truck of the Civilian Conservation Corps' surplus was assigned to this district. Although we had need for the truck as a pick-up, we felt it could be more usefully employed in fire-control work if it were equipped primarily as a forest fire truck.

As is the usual case in building something new, it is built, rebuilt, and changed until you arrive at the product desired. The same was true with this fire truck. It was originally equipped in 1943, at which time a Panama pump was installed, together with the connections to a 110-gallon rectangular tank located directly behind the cab in the truck bed. The 300 feet of ¾-inch hose was carried in a box directly behind the tank. Four spray tanks or cans were carried on the right side, as they are at present.

Later, a false floor was installed. Sufficient tools for 15-man crew were stored under the floor, a gas tank and a tool box on top. A crosscut saw was fitted in slots under the spray tank shelf on the right side of the truck.

In 1945 the truck was outfitted with a live reel, a siren on top of the cab, and red blinker lights on each of the front fenders. In addition, a shelf for three more spray tanks was put along the left side of the truck, and two additional tanks were placed in the bed of the truck.

At the present time the truck is equipped with the following:

1 Panama pump.
1 110-gallon water tank.
400 feet of hose (100 feet of 1 inch and 300 feet of ¾ inch).
7 Indian spray tanks.
2 Parco spray tanks.
10 Rich rakes.
2 double-bitted axes.
2 brush hooks.
1 crosscut saw.
1 short-handled, round-pointed shovel.
2 dozen fusees (back-fire torches).
12 carbide lights and caps.
2 kerosene lanterns.

It also has a bamboo mast used to string up the aerial for the portable radio assigned to the truck. It is expected that in the near future permanent short wave radio equipment will be installed in the truck.

The Panama pump is connected so that it can pump directly out of a stream or from the 110-gallon tank, through the live reel to the hose, or from the stream to fill the tank. It is equipped with a pres-

One-half-ton pick-up equipped with 110-gallon tank, live reel, aerial mast, etc.

Rear view showing placement of spray tanks, boxes, rakes, etc. Note false floor which provides storage space for long-handled tools.

sure gage and a pressure relief valve. Ordinary valves, such as are used on inner tubes, were placed on both the intake and exhaust lines so that all water could be removed from tank, lines, and hose by the use of compressed air.

It is possible to fill spray tanks at the read end of the truck by means of a ¾-inch pipe, installed at the bottom of the 110-gallon tank and reaching to the rear end of the truck. At this point a valve and short hose are attached.

This truck, as it now stands, was outfitted at a nominal cost. The only materials purchased were the live reel, miscellaneous pipe, valves and gages, siren, blinker lights, and overload springs. The Panama pump and hose were obtained from another piece of equipment. The 110-gallon tank had been built by the N. Y. A., and the tools included were standard fire tools, already stocked by the Department of Forests and Waters. Most of the other materials used to outfit the truck were salvaged from worn-out equipment.

Most of the credit for the design, actual work of construction, and outfitting of the truck goes to Forest Inspector Jay S. Pees and the various district foresters under whom he served while the pick-up was being transformed into a fire truck.

The following summary of statistics from the records on the use of the truck during the 1946 spring fire season show that the truck has justified its existence in many respects:

It was used on 31 fires, during which time it was driven a total of 348 miles.

The pump and hose were used 20 times, and an average of 220 feet of hose was laid at each fire.

A total of 1,220 gallons of water was used from the tank, or an average of 60 gallons per fire.

On the 20 fires where the pump, hose, and tank were used, the total area burned was 25 acres, or an average of 1.25 acres per fire. Many of these fires were in places where the quick action of the fire truck prevented large fires from occurring.

Spray tanks were used on 16 of the fires, and rakes and other equipment on 9 fires.

Six buildings were saved at several of the larger fires by keeping the fire from the vicinity of the buildings.

The truck was also used to assist the fire department in combating local grass fires in Warren.

In addition to the work on actual fires, it has a prevention value that cannot be calculated. It is used as a part of the exhibits of the Department at local fairs, etc. Its very existence has done much to carry forward the work of forest fire prevention in this district.

We have learned from experience that the main fault is that the truck itself is not large or heavy enough to carry the necessary equipment. This ½-ton pick-up is not a good type of truck for this purpose. The transverse type of springs tends to cause undue sway when turns are made and is a factor that we have been unable to correct. Heavier springs were installed but they failed to give the necessary stability. The wheels have had a tendency to break when the truck is subjected to travel over rough terrain. The type of truck we believe would be much more satisfactory is a ¾- or 1-ton truck with

dual wheels on the rear, and, if possible, a four-wheel drive. Such a truck equipped in the same manner as the one we now have, would be an ideal fire truck for use in forest fire control in this district.

Although most of the equipment on the truck is demountable, the necessity of having a live reel, tank, and hose semipermanently attached to the truck, limits its use for other purposes, except light hauling and transportation. By semipermanent, I mean that it can be removed if necessary, but does entail considerable work.

This district is fortunate in having more than one forest fire truck in our forest protection organization. Many of our volunteer fire departments and one of the large oil industries have trucks outfitted somewhat like the one described here and used primarily for forest fire control work.

We will be pleased to receive comments on our fire truck, and if additional information concerning it is desired, we shall endeavor to supply it. We feel we have an excellent unit, but realize improvements can always be made.

Alaska Helicopter "First."—On July 12, 1946, the Alaskan Fire Control Service, Bureau of Land Management, used a Sikorsky helicopter in transporting men and equipment to a fire located on the south side of the Tanana River, some 26 miles southeast of Fairbanks, Alaska. The brush and grass fire, starting on an Army bombing range, was inaccessible by foot travel, boat, or regular airplanes. Occurring during a prolonged dry period, the fire quickly grew to class E size and seriously threatened a stand of good white spruce timber along the Tanana River as well as considerable wild game and fur animals. In line with a cooperative agreement between this Service and the U. S. Army Air Force personnel at Ladd Field offered the use of their helicopter to the District Ranger at Fairbanks, Theodore R. Lowell. A shuttle service carried 14 men and their equipment into the fire, flying 7 minutes each way and carrying 2 small men or 1 large man with backpack cans and small tools each trip. Flown into the fire in the late afternoon of July 12, the men brought the fire under control in the early morning of July 13. Without the helicopter to move men and equipment, this Service could not have taken any action whatsoever on the fire. It is felt that although the helicopter is at present a very expensive piece of equipment, its use can be more than justified in a country such as Alaska where the population is small and scattered, transportation routes few, and communication facilities inadequate.—Roger R. Robinson, *Acting Chief, Alaskan Fire Control Service, Bureau of Land Management, Department of the Interior.*

VIRGINIA'S USE OF AIRPLANES FOR FIRE CONTROL

HUNTER H. GARTH

Chief, Division of Forest Protection, Virginia Forest Service

The airplane was first used for fire control in Virginia in the southwest district during the spring of 1945, when a few flights were made by the Civil Air Patrol. These flights were made chiefly by the District Forester in inspecting and supervising the control of going fires. It was found that air observation was effective for this type of work, since the progress of the fire, quickest means of access, and other factors could be readily determined. Break-overs and break-over possibilities also proved to be very easy to detect from the air.

By the time the fire season was over the information had spread over the district that the Virginia Forest Service was using airplanes to spot fires and to catch forest fire law violators. This grapevine element later proved to be the most important factor in the air patrol service and has a tremendous prevention value. The psychological effect of knowing they could be observed from a few hundred feet in the air in otherwise inaccessible areas did a great deal to destroy the feeling of security hitherto enjoyed by illegal brush burners and other forest law violators.

In 1946 air patrol was used on scheduled flights in three districts and occasional flights in two of the other districts. From the few flights made in 1945 it was believed that the potential possibilities were much greater in detection and prevention than in suppression of fires. Therefore the patrols during the last two fire seasons were used principally on those phases of fire control. The days the planes were flown were tied in as closely as possible with the fire weather reports. Flights were made only on class three, and higher, days; but on several days of high class danger weather the wind velocity was such that the pilots would not take the planes up. Consequently on those days it was necessary to rely entirely on lookout towers for detection. For this reason and the cost of operation, the airplanes can only supplement the detection furnished by the towers.

The normal altitude flown in the Piedmont and Tidewater was approximately 1,200 feet, at which height the horizon was generally 36 miles. In the western part of the State the altitude varied with the height of the mountains. Under normal conditions the cruising speed was 75 miles per hour.

Detection

It is not anticipated that air patrol will eliminate the present lookout tower system. However, the air patrol could accurately locate any fire or smoker in those rather large areas between towers that are not covered. Then, by dropping a message to the tower, he would enable the lookout to locate the fire on his map and take the necessary warden action.

Prevention

It was in this phase of fire control that the air patrol was of the greatest value. Instructions were given to drop messages on all people found burning brush prior to 4 p. m. It is difficult to say just how

many of these were knowingly burning in disregard of the law or on the assumption that the wardens traveling the roads could not see them. Apparently the majority of the persons on whom messages were dropped were actually ignorant of the law. Of course the novelty of the idea undoubtedly made many people conscious of the law and has caused much conversation among the class of people who are continually being brought into court for violations. It has been excellent advertising and it is felt that those who were caught deliberately breaking the law will refrain from doing so again because of the large number of small yellow planes similar to the patrol planes that are flying from time to time.

The message dropped consisted of a weighted envelope about 5 by 7½ inches containing a message blank asking them to be careful with

Envelope with streamer used for dropping messages, and the material inclosed.

their fire, giving advice on how to control it if necessary. It also has a prevention leaflet with some of the most important fire laws.

The envelope has attached to it a long streamer of bright orange crepe paper which makes it very noticeable while it is in the air and easy to find after it lands. These could be dropped near the fire with reasonable accuracy.

Evidence obtained while the plane was in the air led to several convictions. However, the lack of communication between the plane and the organization on the ground makes evidence hard to get because of the time element. To get names and other evidence for conviction the plane would have to return to its base and telephone the location of the fire to a warden, who would then have to drive to the scene of the fire.

This year it is hoped a better system of communication will be worked out between the plane and the warden organization, whereby quicker action can be taken on both law violations and going fires.

A RURAL FIRE FIGHTING TANKER

August P. Beilmann

Manager, Missouri Botanical Garden Arboretum, Gray Summit, Mo.

The arboretum of the Missouri Botanical Garden is located on the northern edge of the Ozark uplift near Gray Summit in Franklin County. It is not very far from that part of Missouri which "burns" every year. In addition to a tendency of the natives to set fires, there are other possible sources of fire: Two State highways, two county roads, and a railroad. Since the whole arboretum contains only 1,674 acres, it is obvious that fire control work must be good and the detection and dispatching must be as efficient as possible. A cooperative agreement has been worked out with the townspeople under which they furnish some manpower and the arboretum furnishes the

Tanker of the Missouri Botanical Garden Arboretum.

equipment. By the terms of the agreement, every woods, field, or building fire within the school district is the concern of this fire department. A telephone system is used for alarm as well as dispatching.

The equipment in use is unconventional and was designed with the thought that water would not be available unless hauled to the fire. To provide water a 1,025-gallon trailer-mounted tank, divided into four compartments, is used. An International DS–40, 161–inch wheel base truck is used as a tractor. This is equipped with low-speed gear and the dual axle is an underdrive rather than an overdrive. Two pumps are mounted behind the cab. One is a Novo diaphragm, powered by its own motor. This pump is capable of draughting water from ponds and cisterns but so far has not been used for that purpose. The other pump, used for fire fighting, is operated from a transmission take-off shaft. It is a 3-cylinder Deming rated at 22 gallons per

minute at 400 pounds pressure. Four hundred feet of half-inch high-pressure hose is coiled on the side of the tank. Two adjustable fog guns of the type commonly used for orchards and one solid stream gun as used for high shade trees are always coupled and ready for use. Although used only to a limited extent, the high-pressure fog seems most effective in grass fires, and appears to be equally effective on fires in woodlots and buildings. The tank holds sufficient water to operate two hose lines at maximum pressure for 40 minutes. In addition to this, six back pumps are mounted on the catwalks.

This represents a cooperative effort to develop rural fire fighting equipment in the more thickly populated sections where water is generally not available and where the usual high-capacity pumps of the metropolitan area are at a disadvantage.

Effectiveness of Aerial Detection.—In the July 1946 issue of FIRE CONTROL NOTES, William G. Morris discussed results of studies being made of the effectiveness of aerial detection. This article has attracted the attention of fire men interested in possibilities of replacing fixed lookouts by aerial control. Morris' reply to an inquiry on the part of Mr. E. W. Loveridge of the Forest Service sums up some of these questions and may be of general interest. In the article in question Morris reported that only 7 of 14 test smokes were detected from the airplane used in the test. Mr. Loveridge wanted to know whether or not adjacent fixed lookouts would have discovered a higher percentage. The following is quoted from Mr. Morris' comments:

"The lookout which normally covers the drainage in which we set the 14 test smokes at various points unknown to the airplane observer was not manned.

"The nearest lookout was 8 miles south of the airport where the test smokes were kept going continuously while the plane circled overhead. The lookout at that station knew that test smokes were being set on the airport field and he was watching for them. He reported that he could not see the smoke until the end of the test when he used binoculars to watch the plane land. This lookout was beyond the range of visibility for the small test smokes that were used as shown by visibility measurements with a Byram haze meter from the airport. The observations of the airplane observer when at an elevation of 6,000 feet and a distance of 5 miles also showed that the smoke could not be seen from the south which was the direction of the lookout. At the time of day the tests were made, an observer south of the smoke had the sun at his back. When the aerial observer was on the north side of the smoke looking toward the sun the smoke was easily visible from a distance of 5 miles.

"The fact that the aerial observers should miss 50 percent of the smokes set at points unknown to them cannot fairly be used to discredit the efficiency of airplanes for detecting smokes. The smoke bombs used in these tests were the standard Forest Service type described in the equipment handbook. They emit a rather small column of smoke which has been judged to be equivalent to that produced by an area of about 10 by 20 feet of burning coniferous forest duff. The smoke continues for only 4 minutes. If the smoke bombs are placed on the ground under a high forest canopy the smoke may not rise about the canopy in the short period that it is being produced. A natural fire burning for a longer time will usually build up a column of warm air which will carry the smoke above the treetops. More than one-half of the smokes missed by the aerial observer in the Chelan tests were set in places where the smoke did not rise into the sunlight above the timber.

"One great advantage which the aerial observer will always have over the fixed lookout is that he can view any given point from different directions so as to have the greatest advantage of the direction of the sun and color of the background."

As stated in Morris' final paragraph, it is possible to get any standard of detection desired by means of airplanes but the questions that need more complete answers are the proper techniques to be used for aerial detection and the relative cost of needed service in a given area by the two methods. As fast as these things can be determined, the choice or combination of methods to be used will no longer be theoretical.—*Division of Fire Control, Washington Office, U. S. Forest Service.*

FOREST FIRES AND SEA BREEZES

G. L. Hayes

Forester, Southeastern Forest Experiment Station, Asheville, N. C.

Spot fires which started upwind from going forest fires have been reported by I. S. Stivers, Forest Ranger for the New York Conservation Department, whose district covers eastern Long Island. They had been observed on a number of occasions, and from a number of different fires.

Suspecting at first that incendiaries were setting fires behind him, Stivers sent patrols upwind from going fires. The patrols found no incendiaries but they did find new fires starting. They, and he, also observed that the smoke column, after rising high in the air, turned and moved back in a direction opposite to the surface winds. The spots were starting from embers which fell from this smoke column.

On other occasions, Stivers wrote, surface winds changed abruptly in midafternoon from a northerly or westerly to a southerly or easterly direction, carrying going fires in an unexpected direction and upsetting suppression plans. A typical case was a fire on Sunday, April 1, 1945, at 2:30 p. m. that started with a northwest wind and began to spread to the southeast. Fifteen minutes later the wind shifted fast to the southwest and sent the fire over the Radio Corporation Communications plant at Riverhead.

The conditions described and the location, on Long Island, indicate that the type of local winds known as sea breezes was responsible for both the upwind spot fires and for the rapid changes in direction of the surface wind. Much has been learned about sea breezes in recent years that should be of very material help in planning fire suppression in such coastal areas as Long Island. Obviously, fire suppression is most difficult when rapid and unexpected changes in wind conditions occur. If the wind shifts can be anticipated, defensive action can be planned in advance.

There is an excellent discussion of sea breezes in the June 1946 issue of the bulletin of the American Meteorological Society under the title "Theory and Observation of Land and Sea Breezes," by Raymond Wexler. As many fire control men in coastal areas may not have access to the Bulletin, the following digest of Mr. Wexler's article has been prepared. The land breeze is not mentioned as it occurs mainly at night and is felt primarily over the water.

Definition and Characteristics of Sea Breezes

A sea breeze is a local circulation in which the wind near the surface blows from the water onto the land and returns at a higher elevation from land to water. During the daylight hours the air is heated more

over the land than over the water. This sets up a local pressure system that induces the warmer, lighter land air to rise and flow seaward and the colder, heavier air over the water to settle and flow landward.

The sea breezes occur on warm days near the shores of large bodies of water. They are strongest and best developed along the seacoasts but occur also along the shores of bays and large lakes. In the temperate zone the landward flowing wind current may be from 200 to 2,000 feet thick and may reach inland for 20 to 25 miles. Above this is the return current. Under the same conditions it may extend offshore as far as 60 miles over the ocean. In hotter climates or in combination with topographic winds the inland range is extended. The winds from lakes extend shorter distances.

Two distinct types of sea breezes are recognized. The first type develops when there is little or no gradient wind;[1] the second type develops when there is a light offland gradient wind. The first type develops as a small circulation near the shore early in the day, soon after the air over the land has become warmer than the air over the water. With continued heating of the land, the circulation extends progressively farther landward and seaward and grows stronger and deeper. The second type, which is the more common in temperate latitudes, develops over the water and usually comes onto the land suddenly, later in the day. The offland gradient wind holds the colder and heavier sea air back and heaps it up until the force of the wind can no longer hold it. Then the sea air rushes ashore where it is heated until it rises and joins the gradient wind which is blowing out to sea overhead. The typical sea breeze circulation is then established.

The most dangerous part of the sea breeze circulation, from the fire control standpoint, is the front or surface separating the landward blowing sea air from the seaward flowing land air. The reasons are:

1. The winds blow in opposing directions on either side of the front and rise at the front.

2. The front moves. The rate of its advance is less than the velocity of the sea breeze behind it and it decreases as it moves farther inland. When a front moves across a fire, the rear or a flank suddenly becomes the head of the fire.

3. The winds along the front are the strongest and gustiest part of the sea breeze circulation. Initial gusts of the sea breeze as strong as 34 miles per hour have been recorded, whereas the average behind the front is only about 11 miles per hour.

After about a half hour from the time the front has passed, the velocity is usually very constant, with little gustiness. As the higher winds are then flowing opposite to the surface winds, the danger of upwind spot fires is present.

Although the sea breeze blows from water to land, it does not always blow perpendicular to the coast line. It tends to blow perpendicular at first then shift to the right as the day grows older. Thus, along the east coast where the shore is directly north and south it would tend to start as an easterly wind, shifting to southerly. Along the west coast it would tend to start as a westerly wind, shifting to northerly.

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[1] The gradient wind is the air movement caused by the prevailing pressure differences in the atmosphere. It is the wind that is usually predicted in the Weather Bureau forecasts.

External Factors Influencing Sea Breezes

Several conditions affect sea breeze formation and behavior.

1. *Character of day.*—As sea breezes occur only when the air over the land becomes warmer than over the sea, clear, hot days are most favorable to their formation. They can and do occur on overcast days but they form later, are milder, and extend inland for shorter distances. In general, the clearer and hotter the day, the earlier the sea breeze will form, the stronger it will get, and the farther inland it will penetrate. With light gradient winds and clear skies, it usually starts about 2 to 3 hours after sunrise and ends within 2 hours before sunset.

2. *Gradient wind.*—Calm conditions, or a light offland gradient wind are favorable for sea breeze formation. If the gradient wind is blowing parallel to the shore or off the water, the sea breeze will not develop.

The velocity of the offland gradient wind affects the time of arrival of the sea breeze and the distance inland that it will move. Under calm conditions, the sea breeze may develop near the shore soon after sunup and move progressively farther inland until the maximum temperature for the day is reached, after which is subsides. The stronger the offland gradient wind, the later in the day the sea breeze comes ashore, and it may never penetrate far inland. In fact, if the wind is strong enough, the sea air cannot leave the water. At Danzig a gradient wind of 22 miles per hour was observed just to balance the force of the sea breeze. The front moved intermittently back and forth across the shore line.

To have a front stall over a fire would create a very bad situation. The winds could be strong, and would certainly be gusty and fluctuate wildly in direction, as the front moved back and forth.

3. *Topography.*—Where there are mountains along a shore line, the sea breeze may combine with an upvalley or upslope wind. Such a combination wind is stronger than a straight sea breeze and may extend much farther inland. If the mountains lay several miles back from the coast, separate circulations may be set up in the morning which will merge after noon. Such a combination in California is reported to establish a continuous flow of wind for as much as 40 miles inland. A similar but less extensive flow takes place between Great Salt Lake and the Wasatch Mountains in Utah.

Along the shores of a bay there may be two components of the sea breeze, one from the bay and the second from the sea beyond. The bay circulation will usually be the first to affect the land but may be replaced later by the ocean breeze, accompanied by a change in wind direction.

4. *Vegetation.*—A heavy vegetative cover retards heating of the land surface. Hence, the sea breeze starts earlier and becomes stronger along desert or semidesert coasts than along heavily forested ones. Likewise, with other things equal, conditions along our coast are more favorable to sea breezes when the vegetation is dead and the leaves are off the deciduous trees than after the fields and woods "green up."

5. *Atmospheric stability.*—An unstable lower atmosphere is more favorable for sea breezes than a stable one. In an unsaturated atmosphere, stability depends on the rate of temperature drop with

increasing elevation. If the temperature decreases more than $5\frac{1}{2}°$ F. in 1,000 feet of elevation (or 1° F. in 182 feet), the air is unstable and ascending convection currents develop easily. If it decreases less than this, it is stable and convectional movement cannot take place. Air over the land that is very stable in the morning may, through surface heating, become unstable later in the day, hence the hottest part of the day is most favorable for sea breezes.

6. *Distance from the shore.*—The sea breeze is felt first and has greatest velocity right at the shore. As distance from shore is increased the sea breeze arrives later in the day, has less velocity, and the front moves more slowly.

With so many factors affecting the time of arrival and characteristics of the sea breeze, it is impossible to set up definite rules which will tell when it may arrive or how it will behave for any particular place or day. Where the sea breeze is observed to have important effects on fires, fire control men would profit by observing its characteristics as related to the factors already discussed. Or the local weather forecaster of the U. S. Weather Bureau might be induced to predict the time of arrival, its range inland, and probable velocity at and behind the front.

Revision of Fire Equipment Handbook and Master Specification File.—The Fire Control Equipment Handbook and Master Specification File were compiled in the winter of 1936–37 by a four-man committee at the Forest Service Supply Depot in Oakland, Calif. The specifications became available as fast as they were completed, but the handbook could not be printed and distributed until the spring of 1939. Although the foreword to the handbook provided for periodic revision of both the handbook and the specification file, they became badly out-of-date.

In January–February 1945, the National Fire Control Equipment Committee met and, among other things, designated a three-man subcommittee for revision work. This resulted in a completely revised handbook which was distributed during November and December 1946. A two-man committee was assigned November 1, 1946, for revision of the specification file. These men conferred with fire control and procurement officers at several regional headquarters and with certain manufacturers. They made notes of suggestions for specification revisions, and arranged for data to be sent to the Washington Office for use on this project.

In outlining its work, the committee set up certain objectives with a view to simplifying the specification file and making it of maximum value to handbook users:

1. To eliminate from the file any specification not used, or not likely to be used, in more than one region.
2. To include the full specification, or a reference to an adequate Federal specification, in the handbook description of the item involved.
3. To make all specifications in the file as simple as possible, following a practicable uniform outline.

While further revisions of the handbook cannot be made immediately, the committee is making full notes for revisions required by elimination of or changes in the specifications. These data will be available when amended handbook pages are being prepared, which will probably be in the winter of 1947–48. In the meantime the revised specifications are being made ready for requisition, as provided in the handbook foreword.—*Division of Fire Control, Washington Office, U. S. Forest Service.*

THE AAMODT STUBBY PLOW

E. E. Aamodt
Engineer, U. S. Forest Service

The U. S. Forest Service, in cooperation with the Michigan Conservation Department, has designed a low-cost, double-bottom fire line plow which weighs approximately 255 pounds. The beam and coulter are in one piece, 36 by 18 by $3/8$ inches and made of mild steel plate. McCormick Deering plow bottoms, from 12 to 16 inches, can be used interchangeably, thereby adapting the plow unit to any size

Plow hitched to tractor and in raised position for transporting.

tractor. Oliver bottoms or other types of plow bottoms that can be purchased in matched pairs (left and right) will also serve the purpose. Another feature of the plow is that the hitch and depth control arrangement is designed so that the unit may be used with any type or height of tractor drawbar and will also provide adjustment for plowing depth and proper draft.

By mounting a simple hand-operated winch or gear box type hoist on rear of tractor, the plow can be raised or lowered from the driver's seat and readily transported.

The light weight of the plow requires a tractor of only a comparatively small horsepower drawbar pull and, from tests made in various cover types and soil conditions in the Lake States area, has demonstrated its ability to plow a clean fire line furrow.

Fire line furrow plowed in light sandy soil.

The small size and light weight of the plow also permits easy loading and transporting in a pick-up, passenger car-trunk, or on a small trailer.

The Stubby Plow was demonstrated at the equipment development meeting held at Roscommon, Mich., last June and created considerable interest on the part of fire control men.

Chelan Humidity Finder.—Training and inspection trips this season brought to attention the fact that some of our inexperienced Fire Danger Station operators were having difficulty in locating the correct humidity ready from the U. S. D. A. Psychrometer Tables after the necessary computation was made. While illustrating how the correct figure could readily be found by using two sheets of paper as straightedges (one along the air temperature line; the other along the wet-bulb depression column), it occurred to the author that a simple cardboard device would do the job. Thus, the Chelan Humidity Finder was developed. The device is simple to make, easy to operate with one hand, can be left conveniently in the closed book, and will locate the correct humidity figure quickly.

The finder is made of white cardboard in the shape of a carpenter's square, or an L backward. Its base is 1 inch wide by 5½ inches long, with "Air Temperature" lettered on it. The vertical arm is 1 inch wide by 7½ inches long and has "Depression of Wet-Bulb Thermometer" lettered on it. If desired, the word humidity can be lettered just under the angle on the Finder with a small arrow pointing just to the left of the inside corner.

In use, the device is placed on the relative humidity table with the vertical arm on the right side of the proper figure for depression of wet-bulb thermometer, and the base just under the predetermined air temperature. The figure in the angle between the base and vertical arm is the relative humidity. For example: If the depression of the wet-bulb thermometer (Relative humidity table IX, pressure 25.0 inches) is 9.5, and the air temperature is 69° F., the relative humidity is 59 percent.—SIMEON A. BEESON, *Fire Control Assistant, Chelan Ranger District, Chelan National Forest, U. S. Forest Service.*

AN IMPROVED BROOM-RAKE FOR LINE CONSTRUCTION

PAUL F. GRAVES

District Ranger, Shawnee National Forest, U. S. Forest Service

An article by Perle Lewis in the July 1946 issue of Fire Control Notes discussed advantages and defects of the broom-rake over other rakes for fire line construction.

An improved broom-rake was put into use on the Shawnee National Forest in September 1946. Its use to date has not been extensive in actual line construction, but it has been given severe field tests in

Broom-rake: Improved (left); old style (right). Condition of old style rake caused by slipping of tines and weak construction.

various fuel types. The defects in the old style broom appear to have been corrected without loss of any of the advantages. The replaceable handle is now tapered fitting into a steel ferrule welded to a heavier crosspiece. This has greatly strengthened the handle attachment to the rake without adding seriously to the weight. Notches and clips on the crosspiece prevent the tines from slipping, which was a major defect of the old style.

The broom-rake is very fast and effective in leaf fuels, but it cannot be used to advantage in sedge and heavy grasses, vines, or briers. Heat of fire and hot ashes removes temper from rake tines and in time ruins the rake.

LIGHT TRACTOR-TANKER *vs.* 3/4-TON WEAPONS CARRIER TANKER (FIRE SUPPRESSION WITH HIGH PRESSURE FOG)

J. W. West

Assistant Supervisor, Wasatch National Forest

J. W. Mattsson

Forester, Division of Fire Control, Intermountain Region

Such flash fuels as cheatgrass and sagebrush have increased so rapidly in many areas of Region 4 during recent years that a highly mobile light tanker is one of the Region's chief needs. Fire suppression men have sought a tanker that would meet the following requirements:

1. Be able to leave the road and go into inaccessible country on its power;
2. Be maneuverable under topographic and cover conditions where fires occur;
3. Be rugged enough to stand up under tough demands; and
4. Be readily accessible for holding a fire line or participating in initial attack before ground crews can be dispatched.

To meet this need, a tractor-tanker has been in use on the Wasatch National Forest since 1945. Early in 1946 a weapons carrier (3/4 ton, 4 x 4) was converted to a tanker truck and assigned to the Wasatch Forest. This assignment made possible comparison of two kinds of equipment with approximately the same water carrying capacity under similar terrain and operating conditions.

The tractor-tanker, described on pages 41–44 of July 1946, Fire Control Notes, was equipped with two 53-gallon water tanks—mounted one over each track of the crawler type tractor. Other equipment included a Bean Royal 10 high-pressure pump, 200 feet of 3/4-inch high-pressure hose, and a Bean No. 685 master fog gun. The weapons carrier was converted by installing a 100-gallon tank, a 200 F demountable Bean pump, 150 feet of high-pressure hose, and a Bean master fog nozzle.

Tests provided the following general observations concerning the operation of these two pieces of equipment:

1. The tractor-tanker is slow in getting to fires when compared to the 3/4-ton weapons carrier, mainly because of the tractor-tanker's slow speed of from 3 to 7 miles per hour on its own power. About 15 minutes is also lost in loading and unloading the tractor from the carrier truck. (This 15 minutes is consumed in blocking and unblocking the tractor, chaining it down securely, warming up motor, and getting on and off the truck.) Futhermore, the tractor makes an unbalanced, top-heavy load on the 1½-ton truck, requiring slow and careful driving. To maintain safety, personnel of the Wasatch have to be extremely cautious. The truck travels almost entirely on improved roads on level terrain.

The weapons carrier, however, can travel faster on improved roads than the 1½-ton carrier truck. When it leaves the road, the carrier can travel almost any terrain the tractor can negotiate, and at a much

greater speed. The weapons carrier reaches the actual fire line in much less elapsed time than the tractor, a factor of prime importance in suppressing flash fuel fires.

2. The tractor-tanker ties up two pieces of equipment, itself and the transporting truck. Generally during the fire season the tractor-tanker is kept loaded for quick getaway and thus is unavailable for other uses unless the tanker is unloaded in emergencies.

3. The tractor cannot be used for other project work because it is not equipped with bulldozer and has insufficient power. With a slip-on unit, the weapons carrier can be used for project work during

Three-quarter ton weapons carrier on 47 percent headslope. It stalled at same point going ahead as in reverse.

periods of favorable weather. In 1946 the weapons carrier was used a total of 3,000 miles, with about 1,200 charged to fire suppression, while the tractor-tanker has been used only on suppression.

4. The tractor-tanker is not well-balanced; when climbing it carries all the weight on the rear 1/4 of the tracks. The maximum head slope, or point at which tractor stalls, is approximately 37 percent without pump operating and 30 percent with pump operating. The weapons carrier stalls at approximately 47 percent.

A side slope of 40 percent seems to be the maximum that the tractor can maneuver. If rocks or other obstructions are encountered, especially by the upper track, the tractor tips easily. On slopes of the same type, the weapons carrier tends to slide rather than tip. This is an advantage because the carrier will slide around obstructions rather than climb them and increase the risk of tipping.

5. The tank capacity of the tractor-tanker is limited to two tanks holding 53 gallons each. This is not enough considering the cost of equipment, manpower tied up, and extremely slow time in getting

back to a source of water supply. The weapons carrier can quickly get to a source of water and return. If necessary, its water supply can be increased to 150 gallons. Since the pump and tank is a demountable unit, it could be taken off at a stream or source of water if close to the fire and used like a marine pump. The weapons carrier is then free for other use on the fire.

6. The tractor-tanker unit costs about twice as much as the converted weapons carrier, and its operating cost is much higher.

Region 4 now recommends use of the four-wheel-drive weapons carrier with slip-on pump and tank unit rather than the tractor-tanker. For work in flash fuel fire suppression, the carrier is more efficient and a vast improvement in mobility and general usefulness. Although the tractor-tanker is a good machine, and in 1945 appeared to be the best rough terrain water carrying equipment available the weapons carrier meets the requirements of a mobile light tanker in a much better fashion.

Water Conserving Studies

Since the tank capacity on both the tractor-tanker and weapons carrier is limited, experiments were made with various nozzle openings and pressures to find ways of conserving water. Our work was partially simulated by the article in Fire Protection Notes of August 1946, Vol. III, No. 8, Western Fire Equipment Co. This article opens up the question: Why use high pressures on some types of fuels when lower pressure could conserve water? Table 1 gives the relation between disk size and gallons per minute discharged at various pressures with the Model 685 Bean master fog gun, used on both the weapons carrier and tractor-tanker.

TABLE 1.—*Water discharged by Model 685 Bean master fog gun, at specified pressures and disk sizes*

Disk No.[1]	Rate of Discharge,[2] at— 400 pounds	600 pounds	800 pounds
	Gallons per minute	*Gallons per minute*	*Gallons per minute*
3	1. 0	1. 2	1. 4
5	2. 4	2. 9	3. 4
6	3. 4	4. 2	4. 9
7	4. 6	5. 7	6. 7
8	6. 0	7. 4	8. 5
10	9. 2	11. 4	13. 0
12	13. 9	17. 0	19. 9
14	21. 1	25. 8	29. 9
16	31. 7	39. 0	44. 5
18	34. 0	41. 6	47. 9

[1] Disk numbers represent 1/64ths of an inch—that is a No. 3 disk has a hole 3/64 inch in diameter, etc.
[2] Discharge capacities of gun are for adjustment in straight or full stream position wide open. Usual long fog position gives about 20 percent less capacity.

It is evident from table 1 that if we can fight fire successfully with a lower pressure and a smaller disk, the water supply will last considerably longer. For example, with 400 pounds pressure and a No. 6 disk, the water supply will last twice as long as with 600 pounds pressure and a No. 8 disk: 31 minutes compared with 14 minutes, for the 106 gallons of water available on the tractor-tanker. This extra water supply may be just what is needed. If actual tests show that

good streams of water are furnished and a satisfactory suppression job done with a properly designed small tip, then the water supply can be conserved and the efficiency of the unit increased considerably. After a limited number of tests with different pressures and nozzle openings on different fuel types, the region formulated the following general ideas:

1. At high pressures, 600 pounds and above, the strain on hose, couplings, valves, and other fittings is near the critical point. Maintenance costs are high, the chances of a break-down on a fire are great, and on-the-ground repairs are generally impossible.

2. Basic training of nozzlemen should include thorough instruction on the effect of different pressures at different nozzle openings. Nozzlemen generally accept pressure at which pump is already set and use the same pressure and disk throughout the suppression job. Most of the pressure guns are now equipped with quickly interchangeable disks, and it takes less than a minute to change disks. By using the right disk for the fuel type, the nozzlemen have an effective medium for conserving water even without changing pressure. As fuel types change definitely and the cover is not too mixed, the nozzleman can change disks as frequently as he needs to in order to get the most out of the limited water supply available.

3. For light fuels such as cheatgrass and with an $^{8}/_{64}$th-inch disk, 200 to 300 pounds pressure is generally adequate. Tests with smaller disks indicated that there is not a sufficient margin of safety on cheatgrass type with only 200 to 300 pound pressure.

4. For heavy fuels, such as sagebrush and oak, 400 pounds pressure and an $^{8}/_{64}$th-inch disk did the job safely with the least expenditure of water. With still heavier cover type such as thick oak it might be necessary to increase the size of disk or pressure in order to get the stream of water to the source of fuel. Pressure of 200 pounds and a No. 6 or No. 8 disk appeared inadequate for a hot fire, where rate of spread might be faster than rate of suppression.

5. For the tests conducted in sagebrush, cheatgrass, and oak brush, which may not be conclusive, there seems to be no material advantage in using 600 pounds pressure over 400 pounds pressure.

6. Another important consideration, besides the saving of water in using lower pressures, is the increased efficiency of the nozzleman.

At lower pressure he can handle the hose and pressure gun with less strain, direct his stream of water more advantageously, and—if he does misdirect it—wastes less water.

7. A semifog, in the tests conducted, was more effective in extinguishing the sagebrush and cheatgrass fires than a full stream or complete fog. A full stream puts too much water in one place on one small area; a full fog cooled down the outer extremities of the fuel but did not reach down into the heavier fuel underneath, which would immediately blaze up after being left a few seconds. Semifog not only cooled down outer edges, but had mechanical force enough to penetrate into the piles of fuel and duff. Semifog also has an advantage over full fog in that the operator does not have to get as close to the fire in order to direct an effective stream of water on it.

Much more study needs to be given to the effect of pressures and disk openings in relation to fuel types. Our preliminary tests are indicative only; a more detailed study could also be of value in determining the most efficient pressures at various nozzle openings.

Parachuting Heavy, Odd-Shaped Objects.—An irrigation company renewing a dam in remote country on the Bitterroot National Forest hired the Johnson Flying Service to drop some heavy iron parts of the headgate at the dam site. Region 1 furnished parachutes and technical advice and obtained the details of operation given in table 1. The heavy, odd-shaped pieces were dropped from an altitude of approximately 300 feet while the plane traveled at nearly 100 miles per hour. Spotting was good, except that a longer lead should have been given the heavier objects. All landings appeared easy.

It is concluded that heavy, odd-shaped objects can be successfully dropped from a plane by using one or more chutes and discharging the package so it does not roll.—James V. Waite, *Foreman of Parachute Squads, Northern Region, U. S. Forest Service.*

Table 1.—*Object dropped and parachute operation*

Object	Dimension	Weight	Discharge	Parachute operation			
				28-foot chutes	Attachment to object	Estimated distance for canopy to inflate	Estimated rate of descent
		Pounds				*Feet*	*Feet per second*
Gate stopper	3′ 3″ x 3′ 3″ x 7″	585	On edge from greased slide by 3 men. Did not tip or turn over.	[1] 2	At 1 point at rear	[2] 140	[3] 20
Gate frame	3′ 10″ x 3′ 7″ x 4½″	425	On edge from slide by 3 men. Did not tip or turn over.	[1] 2	At 2 points 2½ feet apart at rear of frame. Cargo chute webbing fastened around frame.	[2] 120	[3] 19
Threaded bar	9′ 4″ x 3½″ diameter	250	From door by 1 man	1	Chute webbing on threaded end one-third distance from end so bar would land at an angle with threaded end up to avoid damage to threads. ½-inch rope wrapped around webbing and bar to prevent slipping.	100	17
Angle irons	7′ x 6″ x 6″	150	do	1	At end of irons. Two strand No. 8 wire passed through holes in irons and wrapped with canvas. Chute webbing passed through wire loop.	85	16
Cylinder stand, hollow	Bottom, 2′ 5″ x 12″ diameter; top, 2′ 5″ x 9″ diameter.	100	do	1	½-inch ropes, padded to prevent shearing, passed through holes in top formed 3 loops to which webbing was secured.	85	16

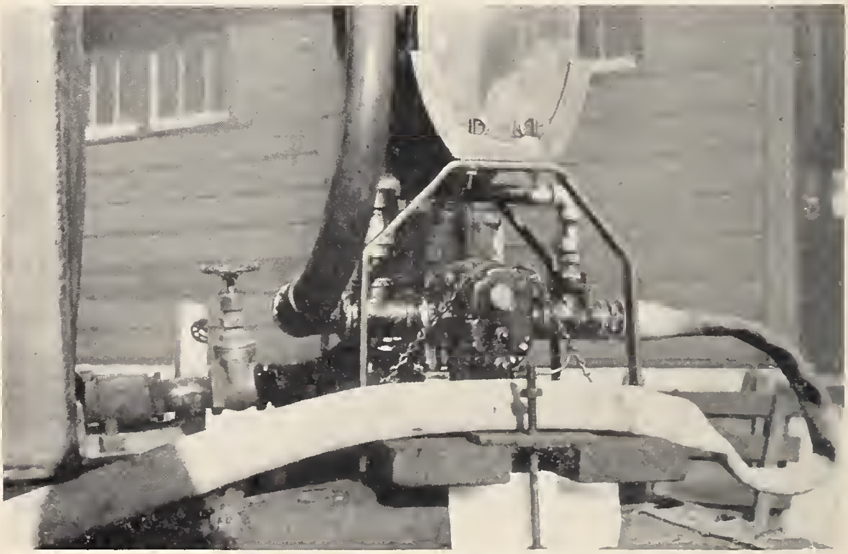
[1] 2 static lines used.
[2] Required slightly longer to open because of weight of object.
[3] Slightly more rapid than normal.

SHASTA COFFIN TANKS AND TRAILER

M. O. Adams

Central Dispatcher, Shasta National Forest

Since the beginning of the Forest Service, every man who has combated forest fires has tried to develop new methods of getting water to a fire for suppression and mop-up. Such a problem confronted the firemen on the Shasta National Forest and in order to overcome this, firemen first developed small initial attack tankers that carried a small tank of water under air pressure, which in later years grew to our



Mounted Pacific Pump showing tie-down bracket and bolt.

powered pump units. This answered some of their problems but the need for a larger unit developed, and the large 450-gallon primary tanker was placed in service.

As each problem was answered, another developed. We had small initial attack tankers and primary tankers of the larger sizes which, after arriving at a fire that had spread to major proportions in rough terrain, could be used only along roads and in servicing the fire camps. The crew tanker, in many instances, was used to haul water to a certain location on the fire and from there it was packed in back pumps to the fire line. The cost of operation of the unit was high and because of this, separate water supply units and tank trailers have been developed on the forest.

Ranger Oscar Barnum of the Pit District developed the idea of a slip-on supply unit. During the winter of 1937 he obtained a large tank from a logging operator who had used it for sprinkling logging

roads. This tank was mounted on skids. Ranger Barnum then connected a Bingham portable pump to the tank. The completed unit was mounted on a loading platform and whenever the need arose for this unit, a ton and a half stakeside was backed up to the loading platform and the tank unit skidded onto the truck. This tank held approximately 800 gallons of water, and supplied the smaller tankers on a fire. Where a dry camp was established, the tank furnished water for camp needs. During the mop-up stage on a large fire, Ranger Barnum was able to release his initial attack tankers and return those crews to their stations while the large unit remained at the fire with a crew to complete mopping up.

Melvin Barron, former Ranger of the Goosenest District, had also been working on the idea of a large water supply unit that could be

Coffin tank and Berkeley pump.

used for any type of servicing and for releasing the initial attack tanker on fires that had gone into the mop-up and patrol stage.

During the summer of 1938 Ranger Barron drew the design of the present Shasta Coffin Tank and had the Klamath Iron Works at Klamath Falls, Oreg., fabricate a 500-gallon tank at a cost of $60. To give it greater stability and also to prevent surging effects, Barron had two baffles installed. He mounted the completed unit on 8- by 8-inch skids, leaving ample room beyond the rear of the tank for a platform to hold the pump unit. A Pacific portable pump was used for the power unit, and to prevent the necessity of stopping the pump every time the nozzle was shut off, a bypass was built into the pump unit. Because of the shape of the tank, some unknown person tacked the name Coffin Tank to this unit and since that time the name has stuck. Units developed by Rangers Barnum and Barron were so successful that the Shasta Forest purchased two additional tanks during the 1938 fire season and six more in 1939. The power units for these tanks were either the Bingham portable pump or the Pacific type portable pump, both mountable on the pump platform at very short notice.

A better power unit for these tanks was provided when the California Region came out with the Berkeley two-stage centrifugal pump powered by a one-cylinder Wisconsin air-cooled engine, a semiportable type. Firemen were able to instruct an experienced truck driver on the operation of the Berkeley pump in a very short time.

Seven coffin tanks are stored at the Mount Shasta supervisor's headquarters as part of the forest fire warehouse stock. To expedite loading, all the tanks are stored on a special platform with pipe rollers. Whenever a call for a tank is received, a 1½-ton truck is dispatched to the rack where two men roll a tank onto the truck. The truck then returns to the fire warehouse where a pump is mounted, suction lines connected, and the required amount of hose and pumper box is placed on the unit. A chain binder ties the tank to the truck.

If the fire is close to water supply points, the truck is dispatched with an empty tank to be filled near the fire. Should the fire be remote from

Tank storage and loading rack.

water, the unit is filled at the supervisor's headquarters with 500 gallons of fresh water and dispatched to the fire.

To expedite the mopping up of larger fires during the 1938 and 1939 fire season it was necessary to tow regular tankers and coffin tank units up steep portions of fire lines that had been constructed by bulldozers. In some cases towing damaged trucks and tankers.

George K. Fox, former fire control officer of the Shasta Forest, conceived a unit that could be pulled by either a truck or bulldozer. Incorporating all the features of the coffin tank, it would be a trailer unit which could be pulled to any location on a fire where a bulldozer had constructed a fire line and could be used for the tow unit. In more favorable terrain the tow unit could be a stakeside.

In the winter of 1939 the equipment shop at Redding constructed the Fox trailer unit, using a standard 1½-ton truck rear axle with dual wheels at a cost of $150. Scrap truck-chassis iron was used for the framework and the tongue was constructed of very heavy steel. This tongue was fixed to the trailer chassis by means of a hinged connection.

The tongue rode in an enclosed slot making it possible to lower or raise the tongue for attaching to either a bulldozer or a truck.

The trailer bed was built of 13-ply plywood to which the tank was bolted. Ample room was left on the trailer bed for mounting a Berke-

Tank rack showing pipe rollers.

ley centrifugal pump. Brackets for holding suction hoses were placed on the top edges of the tank, and at the rear and top of the tank a live hose reel was installed. By placing the live hose reel on the top of the tank, the nozzleman was able to unreel the hose on either side of the trailer unit without any trouble. Mounted forward of the pump unit, the tank acted as a protective shield for the pump. Just forward of

Shasta Coffin Trailer.

the tank is a tool box to hold the necessary connections, spanner wrenches, lubrication oils, strainers, etc.

On the under side of the tongue, forward of the tongue slot, a special jack slot was constructed so that a hydraulic jack could be inserted to lower or raise the tongue when connecting the trailer to a bulldozer or a truck. This jack could also hold the trailer unit in a loading position when the unit was not in use.

The coffin trailer unit has been used since the 1940 season and as soon as a fire boss sees that he can use a coffin tank or trailer he asks the dispatcher for the proper units. Both the coffin tank and the trailer have become an integral part of the fire-control equipment on the Shasta Forest.

Other forests in northern California have seen the coffin tanks in operation and often request the Shasta Forest to send the desired

Coffin Trailer valve arrangement.

number of units on stakesides to their fires. The Mendocino, Modoc, and Plumas Forests all used those units in the 1946 season.

By using these units, forests are able to release their initial attack crews much earlies, and to reduce the time required to mop-up a major fire.

The standard squad tanker now costs 23 cents per mile for every mile traveled; when pumping, the squad tanker costs \$6.50 per hour of pump operation. But the coffin tanker costs $12\frac{1}{2}$ cents per mile for the stakeside and \$1 per hour for the pump unit.

During the winter months, one of the coffin trailer units is used to haul water to the Forest Service horse pasture.

These units are also used on hazard-reduction work and highway safety strip burning. During highway safety strip burning, four of the tanks are placed on a semi, providing a 2,000-gallon water supply unit. By this means we keep all our units at the burning job rather than having to pull some out to return to water supply points.

In 1942 all of the coffin tanks were treated with a rust preventive so that any of the units could be used for camp water and for furnishing drinking water to any fire, besides serving as tankers on suppression and mop-up.

U. S. GOVERNMENT PRINTING OFFICE: 1947

INFORMATION FOR CONTRIBUTORS

It is requested that all contributions be submitted in duplicate, typed double space, and with no paragraphs breaking over to the next page.

The title of the article should be typed in capitals at the top of the first page, and immediately underneath it should appear the author's name, position, and unit.

Any introductory or explanatory information should not be included in the body of the article, but should be stated in the letter of transmittal.

Illustrations, whether drawings or photographs, should have clear detail and tell a story. Only glossy prints are acceptable. Legends for illustrations should be typed on a strip of paper attached to illustrations with rubber cement. All diagrams should be drawn with the type page proportions in mind, and lettered so as to permit reduction. In mailing, illustrations should be placed between cardboards held together with rubber bands. *Paper clips should never be used.*

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The approximate position that illustrations bear to the printed text should be indicated in the manuscript. This position is usually following the first reference to the illustration.

VOL. 8 OCTOBER 1947 NO. 4

FIRE CONTROL NOTES

A PERIODICAL DEVOTED TO THE TECHNIQUE OF FOREST FIRE CONTROL

FOREST SERVICE • U. S. DEPARTMENT OF AGRICULTURE

FORESTRY cannot restore the American heritage of natural resources if the appalling wastage by fire continues. This publication will serve as a channel through which creative developments in management and techniques may be communicated to and from every worker in the field of forest fire control.

Volume 8 Number 4

FIRE CONTROL NOTES

A Quarterly Periodical Devoted to the

TECHNIQUE OF FOREST FIRE CONTROL

The value of this publication will be determined by what Federal, State, and other public agencies, and private companies and individuals contribute out of their experience and research. The types of articles and notes that will be published will deal with fire research or fire control management: Theory, relationships, prevention, equipment, detection, communication, transportation, cooperation, planning, organization, training, fire-fighting, methods of reporting, and statistical systems. Space limitations require that articles be kept as brief as the nature of the subject matter will permit.

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Forest Service, Washington, D. C.

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1947

Contents

ON THE PASSING OF DAVE GODWIN

G. A. MacDonald

Washington Office, U. S. Forest Service

A few days ago, Art Brown, Chief of Fire Control in the W. O., asked the writer to do "something on Dave Godwin for Fire Control Notes."

"The magazine was his baby, you know," said Brown. "Roy Headley put him in charge after the Fire Equipment Conference at Spokane in February of '36, when it was decided that a medium was needed for the Nation-wide interchange of ideas and developments in fire control. If "Notes" has been a common meeting ground, a clearing house for the creative efforts and observations of fire fighters in all protection agencies and interested organizations, such as it was intended to be, Dave was mostly responsible."

For a periodical that circulates largely among members of a service most all of whom knew Dave personally or by sight, and certainly all of whom knew of his sudden and untimely death in the Blue Ridge Mountains on Friday, the 13th of last June, what remained to be said about the late and truly lamented Chief of Fire Control and Brown's predecessor?

No doubt, foresters and many others who knew Dave throughout the country experienced the shock which the writer did when, the following Sunday morning, he picked up his Washington newspaper and saw Godwin's photograph on the front page and his name among the air-crash dead. Surely, every Federal forester knew the details of his notably successful career in the Forest Service for those were widely publicized at the time of his appointment to be Chief of Fire Control little more than 6 months before. Surely, most of them read the memorial tribute paid to him as "an outstanding public servant whose record and contributions to the Forest Service and the country were of the highest order," 3 days after his death, by Chief Forester Lyle Watts.

On Monday morning, the writer went straight to Brown's office. Brown had just returned from the scene of the crash where he went to identify Dave's body. As the writer came down the corridor, past foresters' offices, there was a hush over the place; the door of Dave's last earthly office stood open, on the desk was a neat pile of letters, telegrams and memos waiting his return. Brown looked tired and worn. The writer said. "Was he—could you recognize him?" Brown's eyes appeared to retreat into shadow. "Fifteen of the victims were not broken," he said. "He was not among them. It was an experience I hope never to go through again." That was all.

Most everyone knew that only recently Dave Godwin had come back to the neighborhood of beautiful Christ Episcopal Church, Georgetown, and bought a home half a block up the street from this church where he served as a boy. His life had taken him in a wide circle from the time when, in his teens, he ventured west and began his Forest Service career as a guard on the Inyo National Forest in California.

The ability to inspire confidence and liking, the character and integrity that Dave possessed were evidenced by his progress throughout his life. They were strong factors in his rise from forest guard, to ranger, to supervisor on the Mendocino, to fire control planning for the California National Forests. Again, they were evident, in World War I, in which he served 22 months overseas, achieving the rank of captain and being graduated from the Army General Staff College and the Army School of the Line. The war left him with a chronic cough, but it also gave him the respect and friendship of military men that enabled him to bring about Forest Service-Army cooperation in World War II that was of great value to the Forest Service then and promises to be in the future.

For a time after World War I, Dave was in business in New York but the writer knows, more from impressions gained from general comment on Dave's part than from any direct statement, that his years in that highly competitive and materialistic hurly burly were the least happy of his life. On the other hand, while it was still an official secret the writer learned that Dave was to succeed Pat Thompson as Chief of Fire Control. He went to Dave and stuck out his hand, without a word. Dave's handsome face lighted, he took my hand and said, "Thank you, Alan." That was all, but there was about him the air of a man who had achieved the position that he wanted more than any other—Chief of Fire Control in the United States Forest Service.

To an old newspaperman like the writer, Dave had one characteristic that seemed particularly valuable. He had of course a strong dislike for inaccurate, sensational statement, and I think never felt quite comfortable when stories for newspapers were being prepared. Yet for all that he realized the value of publicity—for all its frequent and often unavoidable errors—and he handled newspapermen with great patience and respect, giving of his ideas and time to the utmost whenever required. He was particularly good in this connection when talking about the "smoke-jumper" program, the use of airplanes and other equipment in forest fire control, direct, informative and full of his subject. And in that hectic world of newspapermen he had his accolade. The writer does not know how many men came to him with a word about Dave Godwin in the National Press Club following his death, but there were many. To men who are always talking about "stuffed shirts" and "cheap skates" and "publicity hounds," Dave Godwin was "a grand guy."

Progress Report on Smoke Masks and Goggles.—A study was made of available commercial smoke masks and goggles to determine the most efficient mask for forest fire fighting. The final tests and analysis were made by Engineer E. E. Aamodt. The five most promising masks were used on a peat fire in the fall of 1946. This test demonstrated conclusively that a fire fighter properly equipped with mask and goggles could do a more efficient job and remain on the fire line under conditions that could not be tolerated for long otherwise.

The tests indicate that goggles of any kind are of considerable value. No great difference in the effectiveness of the different types tested could be noted. The chemical stick (pencil) and treated cloth furnished with some goggles to clean and oil the glasses, to prevent moisture condensation on them, had some slight value, and the double lens goggles with the water filler also had some value in retarding condensation. However, not enough moisture condensed on any of the goggles to impair vision more than about 10 percent. The double lens type goggles performed equally well with or without the water filler, and were somewhat better than any of the single lens types.

The combination goggle and mask is quite bulky and is not as desirable as the separate units.

The Pulmosan mask, No. GR–250, which costs $6.86 with built-in goggles and is equipped with a small chemical can cartridge for absorption, was considered to be the best all-around mask tested. It was superior to the Cover's mask, the Dupor mask, and the Army's M4A1 Carrier gas mask. The ordinary hospital cotton gauze mask, which costs about 20 cents, proved to be about equally as effective as the Pulmosan mask. This gauze mask, kept wet with water, appears to provide all that is needed in a mask by a fire fighter. From a sanitary point of view, it can be thrown away after use. Several can easily be carried in a pocket, and they can be purchased in most drug stores. We propose to adopt the Hospital Gauze Mask as standard for use in Region 9.—J. M. WALLEY, *Fire Control Chief, R–9, U. S. Forest Service.*

THE FOREST FIRE HAZARD IN THE SUNSPOT CYCLE

William M. Morris

Forester, Land Economic Inventory and Land Use Section, Wisconsin State Department of Agriculture

That sunspots affect the weather is no longer a matter of conjecture or debate. Numerous studies have shown that the number of sunspots increase to a maximum and decrease to a minimum in cycles and weather changes occur in similar cycles. The sunspot cycles and the accompanying weather variations can now be predicted with reasonable accuracy. These weather variations materially affect the forest fire hazard. By knowing when the cycles of bad fire weather will occur, the forester can better plan his land management and protection practices to anticipate the periods of high hazard.

This study, made in Wisconsin by the author, indicated that nearly all of the great fires in the State occurred during periods of declining sunspot activity. The relationship between sunspot activity and weather variation in Wisconsin may be different from that in New England or the west coast. Weather records for each section of the country should therefore be analyzed individually. The work reported in this article should be considered exploratory only and subject to revision.

Sunspot Cycles

The occurrence of cycles and their length were demonstrated by a curve made from sunspot observations for 100 years at Zurich, Switzerland. The cycles based on this curve are given from one maximum sunspot year to the next maximum year. Between the maximum sunspot years of 1837 and 1937, nine complete cycles occurred. This makes the average length of a cycle 11.1 years, though the duration varied considerably from 9 to 13 years.

Besides the so-called 11-year cycle in sunspots, which is the common and most apparent one, there are undoubtedly longer trends when sunspot numbers are much above or much below normal over an extended time. Such long cycles seem to be accompanied in Wisconsin by generally cool, wet periods when sunspot numbers are high, and hot, dry periods when sunspot numbers are low. A study of tree rings, varves[1] in lake bottoms, and the various flood stages of the

[1] Varve, as defined by Webster, is "an annual layer of silt as deposited in a lake or other body of still water. As individual layers differ in thickness and character, a succession of such layers forms a characteristic group which can be identified as of contemporaneous deposition in whatever deposit it may be found. It is thus possible, by combining different sections, to measure the time involved in the deposition of the entire group of sediments and to construct a time scale in a manner similar to that employed in the study of annual rings in trees."

Nile River substantiates the possibility of these longer cycles.[2] It may be noted by students of the subject that the longer cycles are nearly always multiples of the 11-year cycle.

Weather Periods

In comparing the records of sunspots for over 100 years with Wisconsin weather conditions for as long as records are available, it is found that there are in general two periods of years, or two quite distinct weather seasons, which stand out in marked contrast to one another when placed in their proper position in the sunspot cycle. In these two weather periods the temperature and percent of possible sunshine received in Wisconsin show the most decided contrast though rainfall and the amount of evapo-transpiration also show distinct trends.

Weather period I is designated on the chart as the period when sunspots are increasing and at the maximum number, and weather period II when the sunspots are decreasing and at their minimum number. The first period is much shorter than the second, averaging 4.2 years since 1833, as compared with 6.9 years from 1837 to the minimum year 1944. Since 1837 a fourth year of increasing sunspots has occurred three times, and a seventh year of decreasing sunspots four times. These, therefore, have had to be shown on the chart although they do not occur in every sunspot cycle.

Weather Trends for Each Period

This article is confined to comparison of the weather conditions of this section of the country with the various phases of the 11-year sunspot cycle in order to determine if there is a correlation between sunspots and weather, particularly that type of weather causing forest fire hazards. Weather records have been obtainable for a longer period of time in the southern part of the State but the general weather trends for the entire State in the different years of the sunspot cycle are quite similar. For the fall months (especially October), which have proved among the most disastrous in forest fire history, the records have been taken for the past 48 years for the percent of possible sunshine, 27 years for evapo-transpiration, and 29 years for rainfall and temperature. Whether it is annual, summer, or fall weather, when averaged in the various years of the sunspot cycle the trends are similar; that is, cooler with more general rainfall the first few years of sunspot increase, hotter and drier conditions when sunspots are decreasing. At sunspot maxima, however, the summer and fall months in Wisconsin have been somewhat deficient in rainfall and cooler than in other years of increasing sunspots. At about the sixth or seventh year of decreasing sunspots there occur suboscillations in weather with opposite seasonal reactions in the atmosphere to the above general trends. The curves on the chart indicate these opposite reactions clearly. In other sections of the country these conditions may be reversed.

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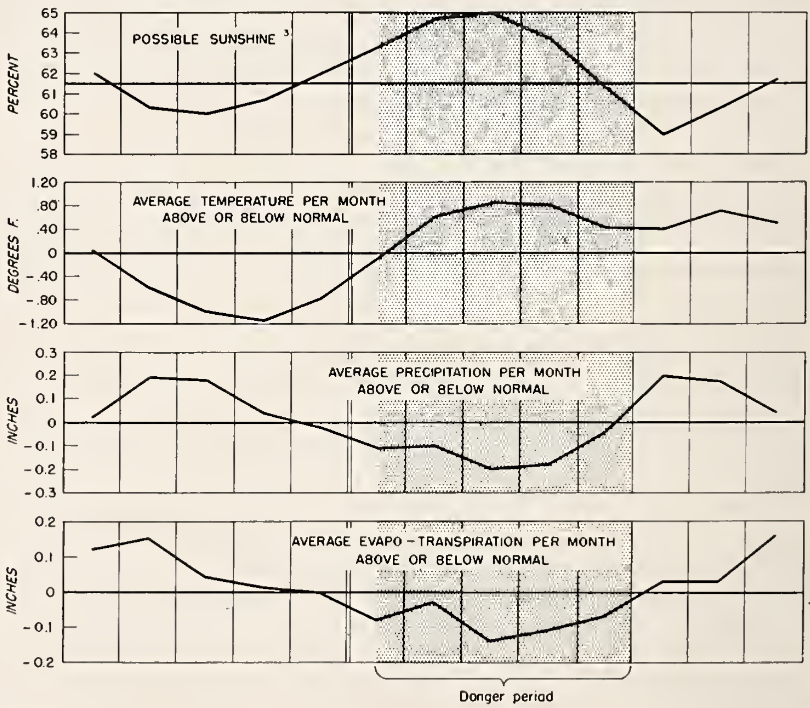
[2] Wood, S. M. THE PLANETARY CYCLES. Ill. Engin. Pp. 5–18. February 1946. Gillette, H. P. WEATHER CYCLES AND THEIR CAUSES. Water and Sewage Works 93: 252–254. June 1946.

THE SUNSPOT CYCLE[1]

Increasing Sunspots – Weather Period I					Decreasing Sunspots – Weather Period II							
First Year	Second Year	Third Year	Fourth Year	Maximum Year	First Year	Second Year	Third Year	Fourth Year	Fifth Year	Sixth Year	Seventh Year	Minimum Year
					[2]**1828**	1829	1830	1831	1832			1833
1834	1835	1836		1837	1838	1839	1840	1841	1842			1843
1844	1845	1846	1847	1848	1849	1850	1851	1852	1853	1854	1855	1856
1857	1858	1859		1860	1861	1862	**1863**	**1864**	1865	1866		1867
1868	1869			1870	**1871**	1872	1873	1874	1875	1876	1877	1878
1879	1880	1881	1882	1883	1884	1885	1886	1887	1888			1889
1890	1891	1892		1893	**1894**	1895	1896	1897	1898	1899	1900	1901
1902	1903	1904		1905	1906	1907	**1908**	1909	**1910**	1911	1912	1913
1914	1915	1916		1917	**1918**	1919	1920	1921	1922			1923
1924	1925	1926	1927	1928	1929	1930	1931	1932				1933
1934	1935	1936		1937	1938	1939	1940	1941	1942	1943		1944
1945	1946	*1947*		*1948*	*1949*	*1950*	*1951*	*1952*	*1953*	*1954*	*1955*	*1956*
1957	*1958*	*1959*		*1960*	*1961*	*1962*	*1963*	*1964*	*1965*	*1966*		*1967*



[1] Allocation of dates into cycles was determined by observations on sunspots at Zurich, Switzerland.

[2] Severe fire years indicated by underlined bold face figures: 1828, Great fires in Wisconson; 1863, South Shore fire; 1864, Greatest fire; 1871, Peshtigo fire; 1894, Hinkley and Phillips fires; 1908, 1,435 fires in Wisconsin; 1910, Baudette fire; 1918, Cloquet fire.

[3] Curves are based on weather records for May through October for the State of Wisconsin.

The records of the past 109 years in southern Wisconsin indicate that summer rainfall has been average or above 60 percent of the time during weather period I when sunspots are increasing, and 43 percent in weather period II. Summer temperature is average or above 33 percent of the time in period I and 63 percent in period II. Fall rainfall has been above average 50 percent of the time in period I and 37 percent in period II, while temperature has been above average 20 percent in period I and 55 percent in period II. The general trend, therefore, is for cooler and wetter conditions in weather period I and the reverse in weather period II. Many of our hot, dry falls occur in this latter period, and when they follow a similar summer of low rainfall, high temperature, excessive sunshine, and low evapo-transpiration, a forest fire hazard is bound to occur.

The difference in the percent of possible fall sunshine received in these two weather periods is even more pronounced than it is for temperature and rainfall. In period I the percent of possible sunshine received is above the average only 35 percent of the time, while in period II it is above the average 68 percent of the time. This difference in cloudiness in the two periods may account for many of the weather conditions that are produced and has been noted by observers in other parts of the country.

These contrasting weather periods of the sunspot cycle definitely affect the growth of farm crops, such as corn, oats, and potatoes. Corn has produced its greatest yields here in periods of decreasing sunspots, weather period II, while potatoes have done best in the first period with cooler and more moist conditions.

Time of Greatest Forest Fire Hazard

The curves in the chart show a definite period when rainfall and evapo-transpiration are at their lowest and temperature and percent of possible sunshine high. Such a period should produce a relatively great forest fire hazard. This critical time is indicated by the curves as occurring in weather period II from the end of the first, through the fifth year of decreasing sunspots.

It is not true that there is no fire danger at the time of increasing sunspots. However, the danger at this time is usually modified by cooler temperatures. During the third year of sunspot increase, summer and fall temperatures have risen above average in the past, but rainfall and cloudiness were also greater. In 1881, a third year of increasing sunspots, a great fire burned over a large area in Michigan. The years 1880 and 1925 were also bad fire years in Wisconsin, but the fires did not reach the intensity or do the damage of a number of those occurring in the first 5 years of the period of decreasing sunspots. The great Mirimichi fire in New Brunswick and Maine occurred at about the same period of increasing sunspots, but weather conditions in the northeastern region of the country may be the reverse of those in the Midwest. Brush fires which burn so often in the spring with great intensity are usually quite seasonal in their occurrence, rather than governed to any great extent by the definite weather trends of the sunspot cycle.

Great Forest Fires of the Lake States

A study of the greatest conflagrations in the Lake States reveals that all of them fall within the danger period indicated on the chart. A great fire burned over a vast acreage in Wisconsin in the year 1828, a first year of decreasing sunspots. In 1863 the southwest shore of Lake Superior was burned over. In La Crosse, the sun was obscured by smoke for several days and the atmosphere was murky as far as Milwaukee. In 1864 there occurred a very general conflagration, beginning early in the season and growing more intense as the year progressed. The vast pineries of the north were nearly all ablaze. From the Chippewa, St. Croix, Black, Wisconsin, and Wolf Rivers came stories of raging seas of smoke and fire, as well as from Brown, Kewaunee, and Manitowoc Counties. Wausau, Two Rivers, and Neillsville fought off the flames only by the combined efforts of their entire population. Although this was one of the greatest general conflagrations in the State it received scant notice in the newspapers of southern Wisconsin.

The Peshtigo fire, Wisconsin's greatest calamity, occurred in October 1871. Fifteen hundred lives were lost in this fire and 1,280,000 acres laid bare. In July 1894 the Phillips fire killed 300 people and destroyed 100,000 acres of timber. In September of the same year, Hickley, Minn., was destroyed with 12 other towns, 418 lives were lost and 160,000 acres of forest burned.

The year 1908 was a very bad one for forest fires in Wisconsin. In that fire season 1,435 fires were reported burning over 1,000,000 acres, with a property loss of almost $3,000,000. Perhaps the greatest fire year ever experienced in the United States as a whole was 1910. This was the driest year in the records for southern Wisconsin. Fires raged in Minnesota, Idaho, Washington, and Oregon, from July through October. The largest one in the Lake States that year was the great Baudette, Minn., fire of October, which destroyed 300,000 acres of woodland and killed 42 people.

On the afternoon of October 12, 1918, fire started in the timber at Cloquet, Minn., following a shortage of 20 inches of rainfall in the preceding 20 months. Duluth was threatened, and smoke filled the air even in the southern part of Wisconsin. Four hundred lives were lost and property damage reached $30,000,000.

These are nine of the greatest recorded fires and fire years of the Lake States. A check on their position in the sunspot cycle shows that five fall at identically the same location in the cycle, namely, the last part of the first year of decreasing sunspots after sunspot maxima. All of them have occurred in the first 5 years of decreasing sunspots, that is, in the danger period shown on the chart. This relationship can hardly be a coincidence.

Importance to the Forester

In order to predict the periods of greater danger it is necessary to know the years of sunspot maxima and minima. The best authorities are not fully agreed as to the next year of maximum but place it anywhere from 1947 to 1949. On the chart it has been placed at 1948. This should be correct within a year, as also with the other predicted dates. If the maximum occurs in 1947 the dates on the chart should

all be shifted to the right one year. Sunspot years and calendar years do not coincide and this accounts for some difference.

Hotter and drier periods should occur from 1949 to 1953 and again from about 1961 to 1965, according to weather conditions of past sunspot cycles. The forester should take advantage of this knowledge of periodic weather conditions. During the longer periods of sunspot decline, when drought and heat are apt to prevail, he should be especially alert for fire hazards and be careful not to create any. Slashings as a result of timber sales would be a much greater hazard in these years than during the cooler and moister years of increasing sunspots. At such times more rigid rules pertaining to slash disposal and timber sales should be enforced. The forester could also go lighter on forest planting or perhaps not plant at all. At any rate he could exercise more caution and be more painstaking with nursery stock or any forest planting. Especial care should also be maintained before and at sunspot minima which are often excessively dry in the Midwest.

Weather Predictions

The above information as a means of future general weather predictions is based on a study of past weather records as far back as available. These records of calendar years are placed in the various phases of the sunspot cycle and averaged. Curves made from these figures can be used as a basis for future general predictions. They should be worked out separately for various sections of the country.

This work so far is of an exploratory nature only and is subject to revision. Studies in other parts of the world have corroborated its general principles. It will be of great interest, therefore, to check and improve its accuracy by a further study of the weather conditions of the future sunspot cycles. It should prove of value not only in determining the forest fire hazard, but in all branches of forestry such as silviculture, insect control, and forest pathology, as well as in many other walks of life.

A Smoker Fire Prevention Campaign That Paid Off.—Six major logging operations in the Modoc Forest have made the problem of smoker fires in the operating areas serious. In 1943 there were 18 smoker fires on logging operations with 13 of these occurring on the Ralph L. Smith Lumber Co. operating area.

In 1944 Mr. A. B. Hood of the Ralph L. Smith Lumber Co. proposed a campaign for *Safe Smoking*. The company had posters printed at their own expense and carried out a campaign to educate their employees into *Safe Smoking* habits. The campaign emphasized that woods workers should smoke *only* in cleared or posted areas. In addition, the company deposited cooperative prevention funds with the Forest Service to pay for a prevention patrolman. This man worked under the supervision of the Forest Service and made intensive patrols of the logging area and contacted all woods workers to promote the *Safe Smoking* campaign. The results were spectacular with occurrence dropping from 13 in 1943 to *none* for the years 1944, 1945, and 1946.

In 1945 the other 5 operating areas had 13 smoker fires. The operators were contacted by the Forest Service and agreed to follow the *Safe Smoking* campaign in their areas. The results were very good, with smoker timberman fires reduced to 2 for the entire Forest in 1946.

The key to the program is not to deny the woods workers the privilege to smoke but to educate them to smoke *safely* at a cleared landing, dirt road or special cleared area in the woods. This is very effective except for the occasional habitual smoker who might automatically, and without conscious thought, light up and smoke in a dangerous spot.

Legal action against these unsafe smokers is probably the only way to cure them.—RUSSELL W. BOWER, *Fire Control Officer, Modoc National Forest.*

ADAPTING THE "WEASEL" TO FIRE CONTROL

E. A. Grant

Fire Control Officer, Angeles National Forest

The Army amphibious "Weasel" (Cargo Carrier M 29C) had possibilities for fire control work, but how could it be reconverted?

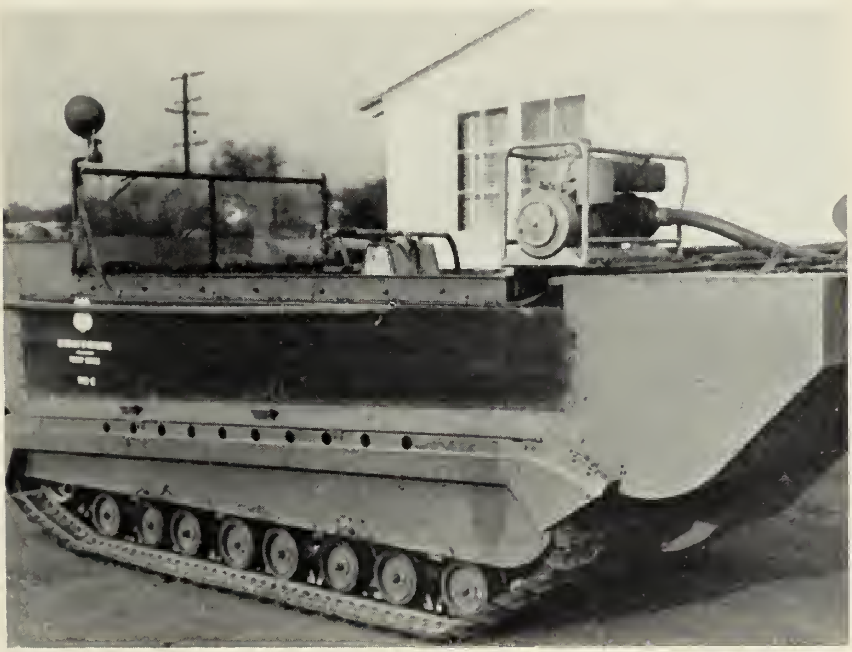
This track laying, amphibious unit should be able to carry crews or equipment across relatively still bodies of water as it was so designed originally. Such a problem faced the Angeles Forest last summer, when water was backed up by a flood control dam in the San Gabriel River. The high water blocked off a road up the East Fork of the river threatening a suppression crew on the west side of the main river with a 30-mile drive with tanker equipment to reach a possible fire just across the canyon. The weasel offered a solution.

After careful thought and several tryouts in another nearby flood control lake, the equipment was selected and distribution of weight was promptly made to allow the weasel to float level in the water.

To meet fire control requirements, the unit must carry the necessary hand tools, canteens, and back-pack pumps. Then, to make it thoroughly useful, and to take advantage of the water it would be used in, a portable pump and sufficient hose to reach a lakeside fire were needed.

Tool arrangement on weasel.

When resting in water, the weasel has a freeboard of only 8 inches from the water surface to the top of the passenger and engine compartment. Possible swamping of the unit is ever present. Life jackets were obtained for personnel protection. As safety of personnel was more than just to prevent drowning, a box was required to hold the tools. The entire equipment was weighed item by item, and the weasel passenger compartment was stripped of miscellaneous fixture, such as one steel bucket seat, miscellaneous brackets, and so forth, to offset the equipment weights and to keep the lowest possible gross weight.



Portable pump mounting on weasel.

Equipment carried in the tool box included two double-bitted axes, two ladies' shovels, two brush hooks, two Pulaski tools, two McLeod tools, and four safety helmets. A back-pack pump was mounted on a bracket in front of the two bucket seats, while a 5-gallon can of oil mixture for the portable pump was placed in front of the tool box. Two hundred and fifty feet of hose was placed behind the bucket seats.

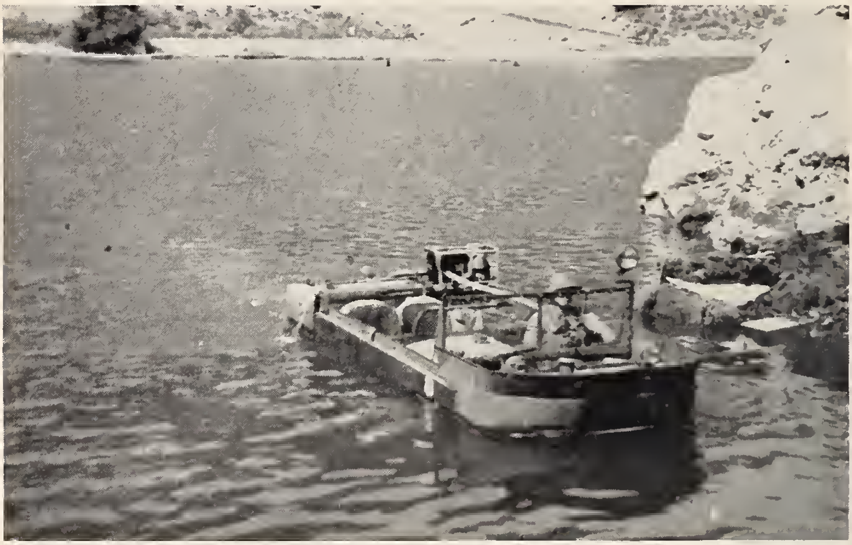
The portable pump was mounted on a special bracket over the rear end of the weasel proper and the rear float tank. The suction hose was looped and strapped to the top of the rear float tank in such manner that by unfastening one strap the strainer was dropped into the water between the two rudder controls. The pump exhaust, because of its water cooling system, was piped to the opposite side of the weasel where it was discharged overboard. This discharge outlet is behind the regular exhaust and muffler and is protected by the muffler's screen mesh wire protector.

During the actual tests in the water with all tools and equipment in place, the weasel rode level. It demonstrated its adaptability to water work, traveling at a speed of approximately 4 miles per hour.

It was also tested in wet sand wash where any other equipment would have bogged down completely and came through with flying colors. In dry sand it did not hesitate.

As for hill climbing, the weasel has been tested on grades up to 71 percent, where it was stalled, not for lack of power, but for lack of traction.

There are some danger points to be watched in the use of this type of equipment. The possibility of swamping while in water must always be considered. All personnel should be required to wear life jackets at all times when the unit is in water.



Loaded weasel being tested.

The braking system is not in proportion to the power of the motor in the unit. The unit will go up steeper slopes than the brakes will hold on when coming down. Auxiliary brakes are required, and these are being developed by the Equipment Development Center at Arcadia, Calif.

The weasel will go through heavy oak brush up to 10 feet high and with stems up to 1½ inches in diameter; larger stems have a tendency to foul the tracks.

In entering the water, the weasel must enter at right angles to the slope of the ground. If one side touches bottom first, the angle of repose may swamp the unit. Underwater obstructions must also be avoided to prevent rupture of the float tanks or the watertight bottom of the unit.

With float tanks removed the unit has been given a baptism of rescue work on the desert near Twenty-Nine Palms, Calif., bringing in nine Air Rescue Service personnel exhausted from hiking under the desert sun in midsummer for 3 days.

The demonstrations described above have shown that a fast crawler-type amphibious vehicle has its place in fire control work. It has possibilities beyond being a piece of suppression equipment such as described here. It can be made into a personnel carrier, which will take overhead or crews up fairly steep hillsides, and so reduce fatigue. By installing a pump and tank in the cargo compartment it will make a fast crawler tanker.

It is a machine of utility to the fire control work, traveling at 32 miles per hour on highways. Night use is also possible with the addition of the proper headlights and taillights. The value of such a vehicle in suppressing swamp fires should be obvious.

A Common Fire Control Fallacy.—Many learned theses have been written on forest fire control. Perhaps too much has been written and too little done. To dispel the idea that this is just another one I want to say right here and now that this is not learned and it is not a thesis. It's just a random thought that perhaps isn't even orthodox.

It's orthodox to consider forest fires as an evil (so far I concur). It is also customary to believe that we will always, or for a great many years to come, have forest fires with us in great numbers, and that we can expect no real decrease in number until most of the old timers who have been accustomed all their lives to burning the woods die off or become too feeble to run the ridges or set fire to a brush pile (and that's the bunk).

Most of the old timers that I knew when I was initiated into the fire game have died and gone to—well wherever these old woods burners go—many years ago. What were then the members of the coming generation from which so much was expected now are the old timers who are still burning the woods. We are now waiting for something to happen to them. Apparently we always have these "old timers" standing between us and our goal of adequate fire control. Why wait any longer? To anyone who says they can't be educated, I'll say that it can and has been done, in one way or another.

Of course it's easier to give a talk and show some pictures to 30 or 40 moppets than to walk up the hollow a few miles to find the old man of some of them, see what makes him tick, and diagnose his case. He's the guy that's doing the devilment and with whom we are currently concerned. Having shown our pictures and said our little speech we console ourselves with the thought that we are making it easier for the next generation of foresters, and then hurriedly muster a crew to stop the fire that got away from the old man while we were thus laboriously preparing for the future.

Work with the youngsters is highly important and far be it from me to minimize its value but it is not more important than working with the old timers whom we are too prone to consider a lost generation so far as fire control is concerned.

Nor should we overlook the fact that perhaps the old man has ways and means that we know not of, or if we do are not permitted to use, of influencing his progeny. I know that the current idea is to "reach the parents through the child" but this has been known to work in reverse and more effectively too than some child psychologists would have you believe.

When I hear that old and oft repeated story about waiting for the old generation of woods burners to die off, it leaves me pretty cold. It's the same old alibi that was used a generation ago. The new generation of foresters should have sufficient ingenuity to think up a better one than that.—S. H. Marsh, *Inspector, Region 7, U. S. Forest Service.*

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FOREST FIRE STATISTICS: THEIR PURPOSE AND USE

J. A. Mitchell

Fire Research, Lake States Forest Experiment Station[1]

Statistics may be defined as organized factual information, particularly information which can be stated numerically. Their purpose is to present related facts, so classified as to provide a basis for sound conclusions or inferences.

Reliable information is the foundation of effective effort—hence the need for adequate and dependable forest fire statistics. They are essential first of all to determine the need for fire control; second, as a basis for protection planning; and third, to properly gage the results of fire control effort. Incidentally, they provide a valuable historical record and data needed to solve many fire control problems.

While usually conceded to be desirable, the value and importance of good forest fire statistics is not generally appreciated. The significance of statistical information is often not apparent until it has been compiled and interpreted. This takes time and effort. As a result, if interest is lacking, compiling and interpreting are put off.

Another reason for our lack of good fire statistics is the fact that, until recently, there has been a deficiency of reliable base data. This has been, and in some cases still is, a serious handicap as anyone who has tried to compile such information well knows. This is no excuse, however, for not making the most of what we have; for even meager data, if properly analyzed, afford much valuable information. Until the need for better data is recognized also, our records will continue to be inadequate.

On the other hand, few realize how much factual information actually is available. The individual fire reports, both State and Federal, for example, contain a world of valuable data which for the most part has never been compiled or analyzed beyond the meager requirements of the Clarke-McNary and Federal annual fire reports. Once the required information has been extracted, these reports are too often relegated to the closed files and forgotten. What is more inexcusable, the reports are not always preserved, with the result that attempts to utilize them later are frustrated by gaps in the record.

Another source of vital information which has received even less attention is the daily fire-weather record. The Forest Service is equally remiss with the States in failing to compile and utilize the information these records contain. Yet what other sound basis have we for comparing the severity of fire seasons and determining the intensity or protection called for by protection units.

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[1] Maintained at the University Farm, St. Paul 1, Minn., in cooperation with the University of Minnesota.

Without knowing the conditions prevailing, how can we hope to plan effectively or judge properly the results of protection effort? How does this season compare with last? We had more fires and area burned, therefore we say it was worse. But did we have more fire days or higher danger? If we did, the poorer record may be justified. If not, we have been slipping and there is some reason to believe that this is the case. Again, the record for the past 5 years on the whole has been excellent and we have been patting ourselves on the back and thinking that we have the fire problem licked. But have we? Isn't it possible that favorable conditions rather than more effective effort are responsible? What would have happened if conditions had been the same as in previous bad years? We may just be kidding ourselves and, when conditions are really bad again, will find that we are not as good as we thought we were. These are just a few examples of our lack of elementary information that adequate fire statistics would supply.

It is true that statistics will put out no fires and that much time and effort can be wasted on their compilation. Without specific information, however, fire control is a matter of guesswork. To the extent, therefore, but only to the extent that they serve a useful purpose are fire statistics justified and their compilation and analysis warranted.

How far a protection organization should go in compiling and analyzing its fire data depends on conditions and the intensity of fire control in effect. The purpose of this paper is simply to point out the significance and use of statistical information in fire control.

In addition to furnishing a historical record, the purpose of fire statistics is to provide specific information as to where, when, and why fires occur and a basis for comparing seasons and protection units and judging the results of protection effort. The essential data are location of fire, date of occurrence, cause, conditions prevailing, action taken, area burned, damage, and cost. This information, in more or less detail, is given in most individual forest fire reports.

The basic statistics derived from these data are number of fires, area burned, loss, and cost.

All other fire statistics, with a few exceptions, are elaborations of this basic information. For example, some or all of these items may be broken down by political or administrative units, by land ownership, intensity of protection, season, cause, type of cover or conditions prevailing, and they may be presented graphically or as totals, averages, or percent.

At present the only forest fire statistics generally available are those compiled annually by the Forest Service, Division of State Cooperative Fire Control, or contained in State and Federal reports. Some States, it is true, break this information down by protection districts and months. Only a few, however, go into any greater detail.

As a matter of record and for general information, these statistics are fairly adequate. They also serve to show the relative over-all size and importance of the fire problem by States. Without further breakdown and elaboration, however, they fail to answer many important administrative and operational questions and do not provide an adequate basis for judging results. A minimum of fire data essential to serve these needs are shown in the check list that follows.

CHECK LIST OF ESSENTIAL FOREST FIRE STATISTICS

(By protection units and years)

Basic statistics:
- Area protected:
- Number of fires: Total and by
  - Cause (lightning, railroads, etc.):
  - Size class (A, B, C, etc.):
- Area burned: Forest, other, and total.
- Loss: Forest, other, and total.
- Cost: Presuppression, suppression, and total.

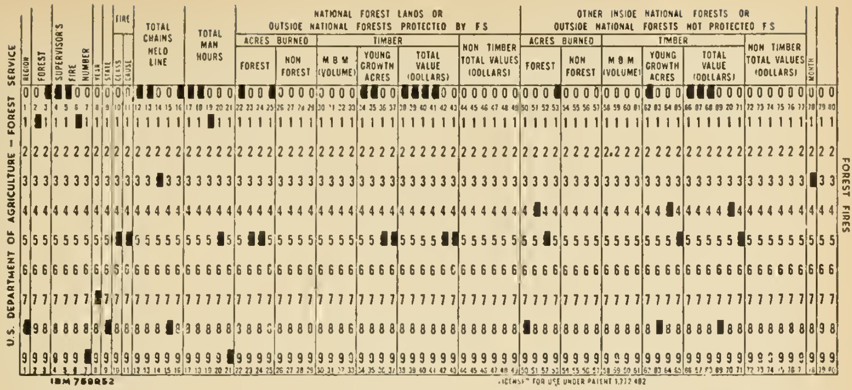
Calculated statistics:
- Danger prevailing (over-all seasonal rating):
- Risk of fires starting (number of fires per unit area):
- Risk of fires spreading (size of average fire):
- Risk of burning (percent of protected area burned over):
- Destructiveness (loss per acre burned):
- Risk of loss (loss per acre protected):
- Presuppression cost per acre protected:
- Suppression cost per fire:
- Effectiveness of suppression (percent of fires under 10 acres):
- Loss plus cost per acre protected (presuppression and suppression costs plus destructiveness):

At the regional level, in addition to the information now compiled, we should have by States and by years all the calculated statistics. At the State level the same information is needed by protection units.

In addition, for sound protection planning, we need to know by protection districts the distribution, concentration, and seasonal occurrence of fires; the normal number of days in each danger class; the normal duration and severity of the fire season; when, where, and how frequently abnormal conditions occur; the variation from normal to be expected; the distribution, concentration, and seasonal occurrence of fires by cause, size class, and fuel types; and many other facts that only a proper analysis of available fire data can supply.

To compile and organize this information by hand is a laborious and time-consuming undertaking and one that becomes more so as records accumulate and data increase in volume. The most practical answer is machine tabulation. While few States have sufficient use for tabulating equipment to justify its installation for this purpose alone, such equipment in some cases is available in other departments or commercially. Another possibility is for a group of States to cooperate in maintaining a tabulating center that would serve them all. The Washington Office of the Forest Service has handled national forest fire statistics in this way for several years and it has not only simplified getting the information desired, but has relieved the supervisors and regional offices of the burden of compiling and tabulating this material.

The machine method of tabulation has many advantages. It not only simplifies and expedites the compilation of required information, but special summaries and tabulations can readily be made at any time, thus aiding in the analysis of the fire problem. The method also has great flexibility and is adaptable to a wide variety of needs, since once the basic information has been entered on punch cards it can be classified and tabulated whenever and in whatever way is desired.

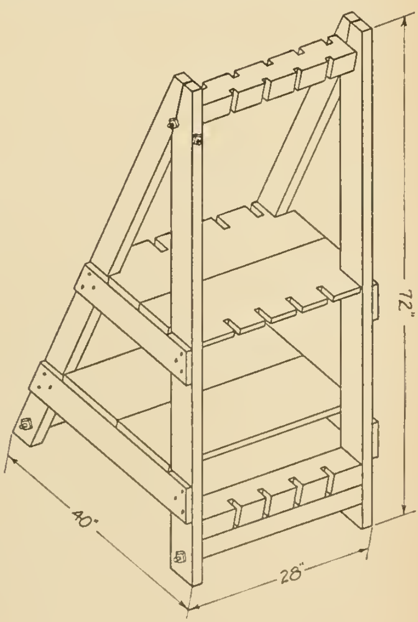


Punch card used by the U. S. Forest Service in tabulating forest fire data.

Since most people are allergic to figures, statistics often fail of their purpose. The remedy is to abstract the essential facts and to present them in more appealing form, either as a running story or by graphs and charts. Graphs and charts are especially useful in comparing conditions and results and in bringing out the significance of specific facts. A running account on the other hand is usually more suitable for presenting general information. Adequate statistics, however, are essential as source material in either case as well as for reference and analysis.

SAW AND ACCESSORY RACK FOR WAREHOUSE USE

A movable crosscut saw rack, as diagramed, is easily made of 2 by 4 and 1-inch lumber to accommodate any number of saws desired. Shelves built inside the frame strengthen it and also give storage space for wedges, handles, and saw guards. The notches which hold the saws are offset so the top ends of the saws clear each other. These notches are ¾ inch wide, 1 inch deep in the top 2 by 4, and 2 inches deep in the top shelf and bottom 2 by 4. A ¼-inch rod through the top and one through each side just under the piece that holds the lower ends of the saws makes the rack more rigid. Aside from the neat appearance the rack provides compact and complete storage for all crosscut saw equipment and can be located in odd corners of the warehouse.—Elvin R. Fellows, *Fire Control Assistant, Stonyford District, Mendocino National Forest.*



TRAINING HIGH SCHOOL BOYS IN FIRE SUPPRESSION

John D. Whitmore

General District Assistant, Glenwood Ranger District, Jefferson National Forest

The manpower shortage brought about by the war is still familiar to everyone who was responsible for recruiting manpower during that period. The warden organization was practically depleted. Private industries which had agreed to furnish manpower for fire fighting were reluctant to close a plant and release their men.

We had a group in our high schools who came from the rural districts. These boys were husky fellows who could do a good job fighting fire if they were properly trained. There were still enough "old men" left in the warden crews to head up groups of 10 or 12 of these boys. So it was decided that the boys should be organized into crews of 10 or 12 with a group leader to work under the direction of a warden or other experienced fire fighter.

Our first attempt at organizing and training high school boys confronted us with several unforeseen problems. First, we found that many principals were unable to see the value of the program and were reluctant to have their school curriculum interrupted. Another problem was to coordinate the efforts of the United States Forest Service with those of the State so as to avoid duplication in the work and to avoid the confusion that was bound to result from having both agencies trying to work independently with each school. A third difficulty was to find a way to get the job of organizing and training done within a reasonable expenditure of time.

It was not easy to overcome the principals' resistance. It has finally been accomplished in most cases by repeated personal contacts, by using patience, and by becoming well enough acquainted with the principal so that we could talk as friend to friend rather than as an impersonal forest officer to a harassed schoolmaster. Contacts by the Forest Supervisor and the State forester to county and State officials of the board of education helped to start the program, but good personal relationships between the men on the ground was the secret of success.

Coordinating our efforts with those of the State was an easy problem to solve. The district ranger and the State district forester agreed that the United States Forest Service would be responsible for training at the 10 high schools nearest the National Forest, that the State would cooperate with us in this training, and that both agencies would be privileged to use the crews. We have found this to be a very satisfactory arrangement. In this way the schools are contacted by only one agency with the result that the interruption of the school program is kept to the minimum.

With the school principals working on our side, and with a definite working agreement with the State forest service, we can now carry on our school program in a manner that is almost routine. The third problem—that of finding time to do the job—has been largely solved by our having a definite schedule so designed that other district work can be done in conjunction with the high school training. The following schedule shows how we do the job on the Glenwood District.

SEPTEMBER 15–30

Truck is loaded with tools for making replacements in warden boxes; paint for boxes and signs; and material for checking and repairing wardens' telephones. The trip is made, taking the wardens as we come to them. A complete job is done at each warden location at this time. That is, tools are checked, poor tools replaced, sign and box repaired and painted when necessary, telephone checked for batteries, etc. A check up is made on the warden crew and its transportation, and revisions are made where necessary. Each high shcool to be organized is contacted and a date for training arranged. These dates are arranged so the training can progress from day to day. At the time this contact is made, parents' consent forms are left to be signed.

OCTOBER 15–30

Spend one day at each school on the following schedule:

9 a. m. Arrive at school. Assemble entire school if possible, girls as well as boys. Give short talk to group as to our purpose at school. Point out good work done by schools in prevention and suppression. Show motion picture to group. Picture should be general conservation film dealing with wildlife, soil, and timber products as well as fire control.

10 a. m. Assemble prospective crew members in classroom. Get principal's idea on desirable crew leaders. Discuss purpose of organized crews and work expected of them in prevention and suppression work. Explain connection between Federal and State fire control work and the difference in wage rates. The county warden should have comments.

Elect crew leader and assistant crew leaders for each 10 to 12 boys. Get names and addresses of all crew leaders. After the crews are organized, spend some time discussing ways of doing prevention work.

Turn job of poster and bookmark distribution over to the crews. Give specific instructions as to where posters will be put up.

11 a. m. Travel to training area in stake truck. Maintain the same order on truck as expected on trip to fire. Take principal or agriculture teacher if possible. Unload tools. Lay them out in same order as used on fire. Explain name of each tool, purpose of tool, proper and improper use, and safety hazards involved. This must be done through demonstration.

12 p. m. Lunch.

1 p. m. Explain organization of crews, line construction, and duties of each man. Ask and answer questions. Return tools to truck and pack in box.

2 p. m. Hold class in conservation work. Show why we prevent fires; the effect of fire on timber and soil; how fire affects the individual. Using an increment borer, Biltmore stick, tape, and Abney level, show how national forest timber is managed and sold. A good location for this discussion is adjacent to a burned area.

Return to school. Give each crew member some good literature or a bulletin to take home.

3 p. m. Have discussion with agriculture teacher and principal. Talk about his job as well as yours. Give him a picture of the job we are doing and how he can fit into it. Spend the necessary time with him to get acquainted.

Let him know you will be back in the spring.

4 p. m. Line up transportation for the crews. Replace No. 1 posters. Do general contact work.

FEBRUARY OR MARCH

Contact schools. Assemble crews in classroom. Take approximately 30 minutes to distribute posters, bookmarks, etc., and give boys pep talk. Check any change in crew and transportation. Contact county school superintendent on this trip.

We have found it to be workable and practical. Notice that much of the program is devoted to prevention work. We have the boys distribute all posters and prevention literature. It is felt that this part of the training pays off by creating interest and making fire-conscious citizens out of these boys who are going to be the leaders in our communities in the near future.

Accurate records have not been kept of the extent these high school boys have been used in fire suppression. But it can be safely said that they have helped us out in times when it seemed almost impossible to recruit even a small warden crew. The principal of one high school has kept a record of the fire fighting he and his boys have done. His record shows that the boys went to 94 fires and 16 false alarms; spent 4,787 manhours fighting fires; traveled 2,730 miles; and received $1,627 in wages. It is interesting to note that all but 19 percent of the time spent by the boys was outside of the regular school hours.

Air Operations Handbook: Cargo Dropping.—Cargo Dropping, a 58-page multilith pamphlet, has been prepared by the Division of Fire Control in Region 6 as one of the chapters of the Forest Service Air Operations Handbook. Factors governing the use of airplanes for dropping cargo in the fire-control system are given briefly. Included in the pamphlet are details of cargo-dropping equipment, how to package and load cargo, methods of transporting and discharging cargo, selection of the cargo-dropping area, and the organization necessary to do a given job. The pamphlet is not yet in final form but was printed in limited quantity to avoid further delay in meeting operating needs this season.—*Division of Fire Control, Washington Office, U. S. Forest Service.*

COMBINATION TREE MARKING GUN AND BACKFIRING TORCH

A. C. Wells

District Assistant, Francis Marion National Forest

This combination marking gun and backfiring torch was developed first as a paint marking gun. The conventional hand oil stream gun necessitated carrying extra paint in a container or returning to a central point for refilling. These operations were time consuming and it was felt that they could be reduced. In addition, the hand oil stream gun required a considerable pull on the trigger in order to make a mark on the tree. A complete stroke was necessary, thus, there was no control over the amount of paint used per mark. All of the above objections have been overcome in the development of the Wells' paint gun which is operated by air pressure. After the gun was completed, the backfiring attachment was developed in order to utilize the abilities of the gun.

The paint gun is made from a Montgomery Ward garden club sprayer with a capacity of 2 gallons and an empty weight of 7 pounds. This sprayer costs $6.39. It came equipped with a spray nozzle and control valve which proved unsatisfactory for our purposes. A Myers spray valve costing $1.35 was put in place of the original valve, and the nozzle from the hand oil stream gun was attached. Straps from a back-pack fire can were placed on the tank so that it can be carried on the back.

The nozzle and spray valve of the Wells' tree marking gun.

Operation of tree marking gun.—The air pump is extracted by turning and pulling up. Air-vent screw is loosened. Marking paint in any amount not to exceed 2 gallons is then placed in the can. Replace the pump. Replace air-vent screw and secure. All connections must be air tight. Then pump air into the gun with an up and down stroke of the pmp handle. Continue to pump until the strokes become difficult to complete. Sufficient air can be placed in the tank with from 60 to 80 strokes. Secure pump handle with clasp for this purpose. By manipulating the control lever tree marks can be made. Only 1 pumping of air is necessary to expend the entire 2 gallons of paint. Paint is completely utilized since the air pressure forces it out of the can. Even after all the paint has been expended, there is still pressure in the tank.

Advantages of the gun.—The can carries a full day's supply of paint (2 gallons). It is back mounted and easily carried. Air pressure operation reduces the work load on the trigger finger.

The gun conserves paint. The amount of paint can be controlled as it leaves the gun thus allowing the operator to use the minimum amount necessary to give a lasting mark. A test of the number of trees marked per gallon of paint revealed that in pulpwood areas the Wells' paint gun averaged 777 while the hand oil stream gun averaged 560. In saw-timber areas where a much heavier mark is necessary, especially when marking cypress and hardwoods, the Wells' paint gun averaged 650 trees marked per gallon as against 410 for the hand oil stream gun.

The marker can mark more trees per hour of marking. Less time is needed to mark each tree since air control gives a quicker mark than that of the manual trigger operation.

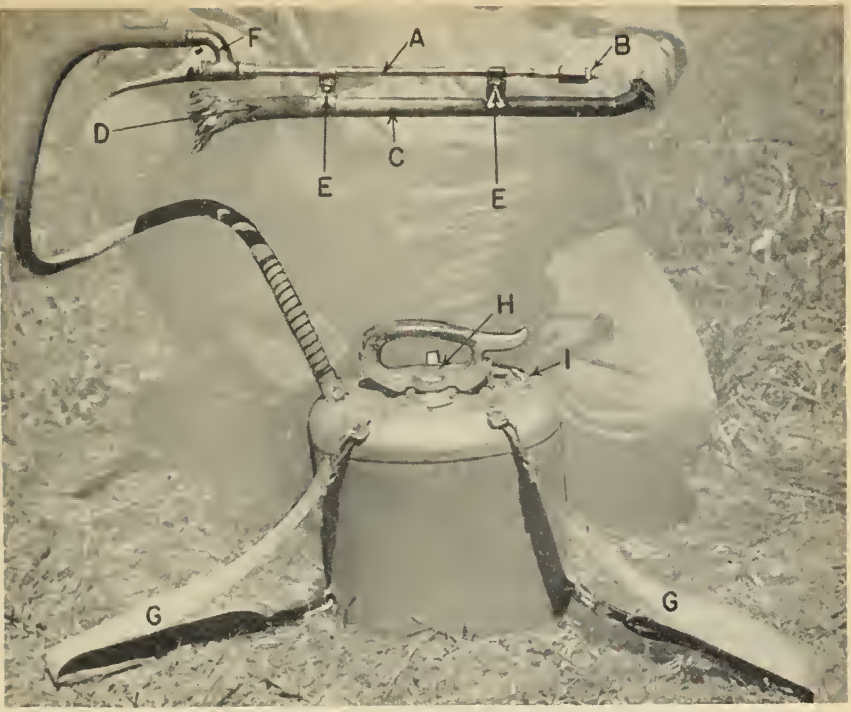
Within a matter of minutes this gun can be changed to a backfiring torch. In the Coastal Plain country, the timber marker has to be prepared at any time to leave his marking to control a fire.

Cleaning the gun.—Remove pump and wash pump and tank with kerosene. Clean nozzle by removing and washing parts thoroughly. Do not attempt to disassemble the pump. The single action of the pump prevents any paint from getting into it, so it is only necessary to clean the exterior. Average cleaning time is 20 minutes. Of course in an emergency when changing to the torch, this operation can be done satisfactorily in a few minutes.

Use as a backfiring torch.—In a matter of about 5 minutes the paint can be removed from the can; paint nozzle removed; can filled with 2 gallons of a backfiring mixture one-half gasoline and one-half kerosene; and the backfiring attachment screwed on.

The backfiring attachment consists of a small pipe, a grease fitting for the nozzle, an inner brass tube of Indian fire can trombone type pump, ordinary wicking, and two clamps.

Operation of backfiring torch.—Operation is the same as for the paint gun except for the use of a fuel mixed half and half, gasoline and kerosene. First moisten wicking with fuel. After initial wetting, the wick will stay wet with fuel thus providing a constant pilot light. Two gallons of fuel, conservatively used will backfire 2 miles of line. This torch gives a maximum of burning fuel to the area to be burned, and with the air-forced stream of live fuel. it is possible to set areas up to 15 feet from the operator. The torch will not be manufactured and used until its safety is assured by a competent testing authority.



Wells' combination with backfiring torch attachment: *A*, Small pipe; *B*, grease fitting for nozzle; *C*, inner brass tube of Indian fire can trombone type pump; *D*, ordinary wicking; *E*, clamps; *F*, spray valve; *G*, back-pack can straps; *H*, air pump; *I*, air-vent screw.

Backfiring torch in operation.

FOG MOP-UP NOZZLES

A. B. Everts

Forester, Snoqualmie National Forest, U. S. Forest Service

Many different types of fog nozzles varying from high to low pressure and from 5 to 54 gallons per minute water consumption are finding favor with forest fire fighting services throughout the country. The Navy all-purpose fog nozzle pictured herein is of the low-pressure type operating at 100 pounds' pressure and using 54 gallons of water per minute. The nozzle is composed of two parts:

(*a*) A bronze nozzle with a handle that can be moved to a shut-off, open, or fog position. When in the open position a straight stream is secured. When in the fog position with the fog disk inserted (shown hanging from chain) a high-velocity homogeneous fog with a projection range of 25 feet is produced.

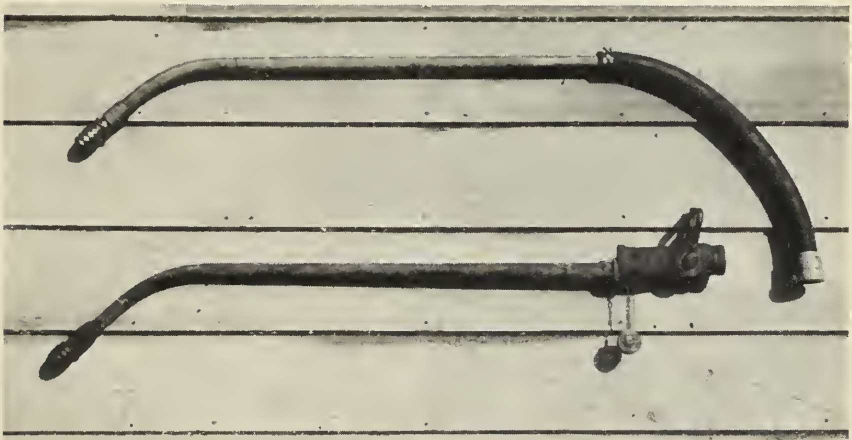
(*b*) A pipe applicator which can be inserted into the bronze nozzle as pictured. The fog tip on the applicator is of the low-velocity type which produces a ball-shaped fog design approximately 16 feet in diameter. It has considerable less projection range than that produced by the high-velocity tip.

Since both of these tips use 54 gallons per minute they are limited for use with low-capacity tank trucks where water conservation is an item to be considered. It has been pretty well established that the efficiency of a fog nozzle is in direct relationship to the amount of water being fogged. Large gallon per minute delivery fog nozzles are, therefore, most useful on pump shows and gravity lines.

This Forest is satisfied that the pipe applicator is about the most efficient mop-up nozzle ever employed. The fog is produced by external impingement, that is, the fog tip is so designed that there are a number of small streams under equal pressure striking each other at right angles. The impact of the streams breaks the water up into fog. There are no moving parts in either of the fog tips, as is the case with the high-pressure fog nozzles. Thus the applicator can be rammed into the deep duff and fuels common to the Pacific Northwest without danger of plugging the tip. Deep-seated burning material around stumps and under logs can be extinguished quickly and efficiently.

Using the applicator with the bronze shut-off nozzle, however, has two drawbacks. The first is that the combination is heavy and tiresome to use for long periods, and the second is there is a tendency for the hose to kink at the nozzle, especially when linen hose is used.

As the result of experience on the East Creek fire, Ross Files of this Forest suggested the improvement shown in the upper nozzle. An 18-inch length of hard rubber hose was clamped to the applicator. At the other end a 1½-inch female coupling is provided for attaching direct to the hose line. This arrangement prevents kinking and reduces the weight from 13 pounds (lower nozzle) to 6 pounds (upper nozzle).



Lower, Navy all-purpose fog nozzle with pipe applicator attached. Upper, an 18-inch section of hard rubber hose replaces the bronze nozzle, to decrease weight 7 pounds and to overcome the troublesome hose-kinking tendency.

TWO-WHEEL MESS TRAILER

John W. Cooper

Division of Fire Control, R–8, U. S. Forest Service

Many plans and styles of camping trailer and mess truck outfits have been designed throughout the country and all with certain advantages for particular conditions. The Francis Marion two-wheel mess trailer, designed by Improvement Foreman R. N. Strickland on the Francis Marion National Forest, is offered herein as being highly adaptable for immediate dispatch of sufficient food for 100 men for 1 meal or for 40 men for 1 day.

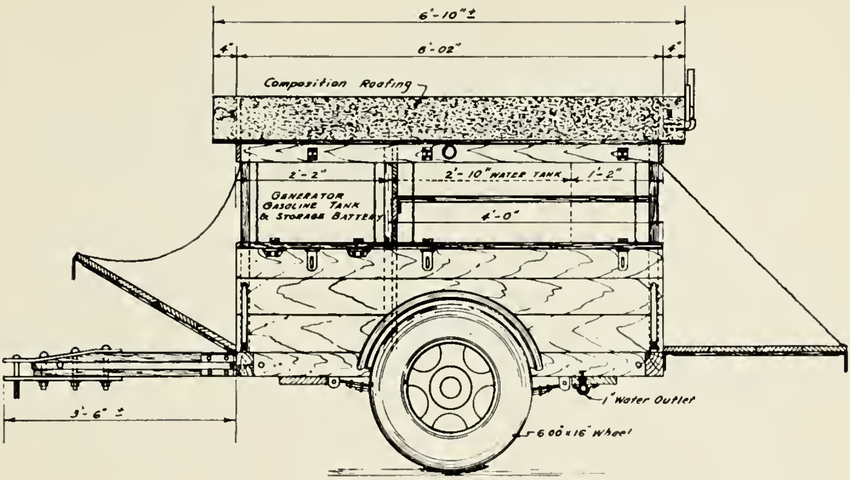
The trailer is light enough to be towed by a one-half-ton pick-up or passenger car, and can be equipped with a standard trailer hitch so that any truck on the district can hook to it and take off immediately for the fire. Two cast iron grills are carried to serve as a stove, and the trailer is always kept loaded with canned and staple food items, cooking utensils, plates, cups, etc., so that it is literally a camp on wheels. Its 40-gallon drinking water tank is a handy convenience.

The trailer carries a 1½-kilowatt gasoline light plant and 100 feet or more of extension cord to be used for lighting the camp area. Sockets are available on all four sides of the trailer to make light for the cook. The use of yellow bulbs repels insects.

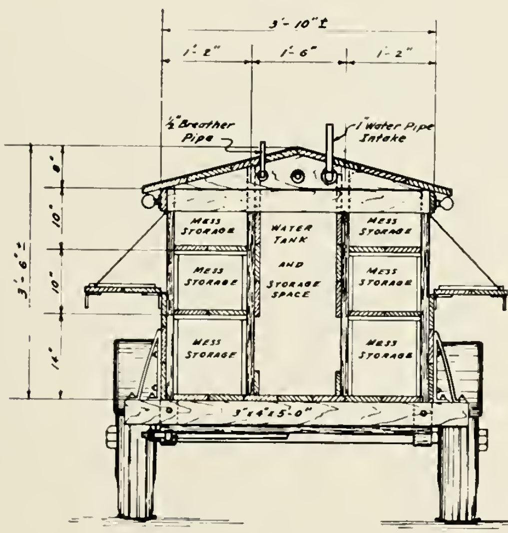
Mess trailer showing: Left end and side gates from rear and Ranger Koen drawing a cup of water; right, front gate, trailer hitch, and light plant.

Among the advantages of this trailer are: The accessible storage of food; the convenient front and rear drop gates that serve as work tables for the cook, and the side drop gates that serve as shelves; simple economic local construction; and the availability of mess gear without tying up a truck.

Construction details are shown in the drawing, which is available by requisition from Region 8 (drawing M–4301).



SIDE VIEW



REAR VIEW

The Francis Marion mess trailer.

Commercial Tackers Facilitate Fire Sign Posting.—Ranger E. A. Hanson of the Toiyabe Forest, tired and a little disgusted with bruised fingers and the job of removing Indian fakir beds of nails and carpet tacks every year from sign backs, looked around for something better than the conventional hammer and carpet tacks. He found it in an automatic tacker using quarter-inch staples. One such outfit costs about $5. Hanson estimates a timesaving of approximately 50 percent per sign and states he is getting a much neater job of sign posting. These tackers are in wide use by business firms, express companies, theaters, and others and can be readily obtained. Rangers having a heavy annual sign posting program may well welcome something like this.—E. A. HANSON, *District Ranger, Toiyabe National Forest.*

FOREST FIRE FIGHTERS SERVICE IN INDIANA

Joseph S. DeYoung

Division of Forestry, Department of Conservation, Indiana

At the beginning of World War II, the fire control problem in Indiana was serious. Many key men, the real "smoke eaters," had joined the armed forces. What manpower would be available to combat forest fires?

In 1942 the Forest Fire Fighters Service (FFFS) was organized in Indiana as a wartime agency. The National Coordinator appointed a State coordinator and an assistant. These were responsible for the organization, publicity, and training work in the State.

At first among the adult groups the progress was very slow. Later the idea of enrolling volunteer members from the Indiana high schools was presented. This proved to be the right move in the development of the Forest Fire Fighters Service.

During the war, the high school students patriotically volunteered their services to help out in the war effort. But how could this work be carried on when the war period ended?

This was made possible by the carefully planned ground work in 1942 when the program started. The school officials, especially in southern Indiana, saw the possibilities of a good conservation training program in the schools. County superintendents, high school principals, civic organizations, conservation club officers, county agricultural agents, and leaders of rural youth groups helped put the program over in their communities. Publicity by newspaper editors and radio broadcasts also helped to get the work before the public.

Just before the expiration of Civilian Defense, July 1, 1945, Gov. Ralph F. Gates wrote a letter to the State forester, a part of which reads as follows: "It has come to my attention that you have done creditable work along the line of training volunteer fire fighters. I would certainly appreciate your going ahead with whatever work you feel essential along this line."

To July 1, 1945, training had been given to boys at 200 high schools in 35 counties, as well as to 1,000 Boy Scouts, 700 adults and 350 high school girls. This made a total of 12,000 volunteers trained. Also 8,000 man-hours were spent combating 238 fires which burned 19,000 acres.

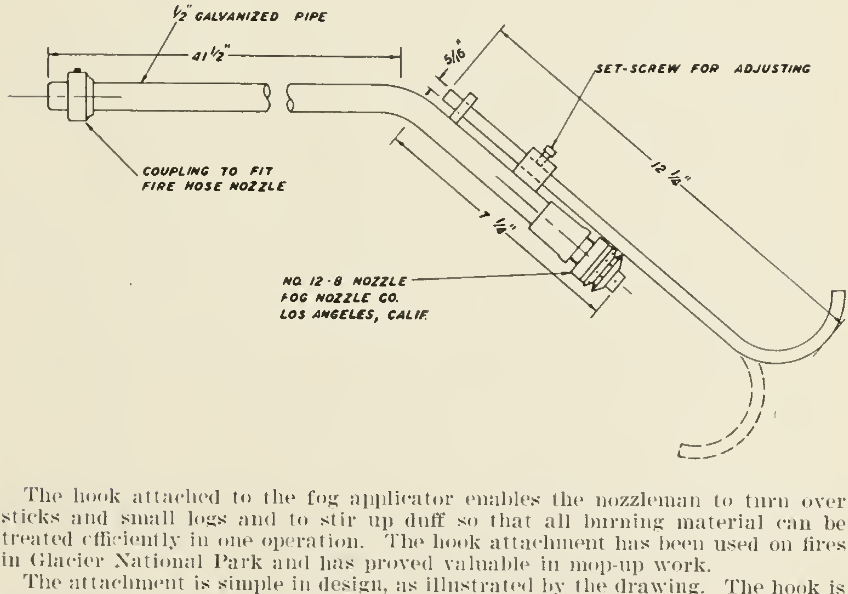
Considerable progress has been made by the Forest Fire Fighters Service. During the period July 1, 1945, to January 1, 1947, training has been given in 100 high schools located in 26 different counties. Five thousand volunteers have been trained, including 3,000 high school boys and girls, 1,400 Boy Scouts, and 500 adults. This makes a total of 17,000 volunteer fire fighters trained to the first of the year. Also 2,000 man-hours were spent combating 100 fires which burned 6,000 acres.

A certificate of merit is awarded to each high school or adult group for their services in suppressing forest fires. There have been 71 awards presented to high schools, and 3 to adult groups since 1942.

Plans have been made to continue and develop the Forest Fire Fighters Service in Indiana by extending the fire training into other counties, appointing additional local coordinators, making new training charts and a fire fighting film, and continuing the contact and follow-up work being done by the fire control personnel of the Division of Forestry, Department of Conservation.

Cooperation by Hoosier conservationists, a thorough and interesting training course given by our training officers, friendly relations with all school officials, and the increased interest in conservation over the whole State of Indiana have all played a part in fostering the continued enthusiasm being shown by students and adults in the FFFS program.

Fog Nozzle Hook.—Fog nozzles have been used effectively in suppressing grass fires and checking spread of certain types of forest fires. In using fog nozzles for forest fire mop-up, however, the effectiveness of this type of nozzle is limited. Most of the cooling action is on the surface and ordinarily it is impossible to reach deep burning fires with a minimum amount of water. The fog nozzle hook was devised to overcome this limitation.



The hook attached to the fog applicator enables the nozzleman to turn over sticks and small logs and to stir up duff so that all burning material can be treated efficiently in one operation. The hook attachment has been used on fires in Glacier National Park and has proved valuable in mop-up work.

The attachment is simple in design, as illustrated by the drawing. The hook is attached to the end of the fog nozzle applicator and is adjustable so that it can be extended or retracted or turned up or down. The five-sixteenth-inch metal rod is heavy enough to withstand fairly rough usage and as much lifting and straining as the applicator itself will stand. The hook also serves as a guard for the nozzle tip.—M. E. SULLIVAN, *Foreman, Glacier National Park.*

THE GILA SMOKE JUMPERS

Don Beck

Southwestern Region, U. S. Forest Service

As an experiment in fire control technique a squad of eight parachute jumpers and one pilot and plane were secured from Regions 1 and 6 for the period May 27 to June 27 for smoke jumping in the Gila Wilderness Area in southern New Mexico. This was the first time smoke jumpers were ever used on fire control in the Southwest.

The wilderness area has rough terrain with altitudes which vary from 5,000 to well over 10,000 feet. An emergency landing strip was constructed near Mogollon at an altitude of 8,500 feet. The higher altitudes and strong air currents created by desert heat were given consideration in planning the action part of the project.

The jumpers were based at Deming, N. Mex., at a former Army air base through the cooperation of the local city officials who had acquired the facilities. Hangar, shop, barracks, and baths were made available. Deming is located within 50 minutes' flight time of the heart of the 800,000-acre wilderness area.

The men and plane arrived on schedule May 27. Between that date and June 27 the jumpers went out on eight fires. At least three of these fires, in all probability, would have reached large acreage and would have been very expensive to control. There is no doubt in the minds of Region 3 personnel that the project proved its value.

During the period of operation all regular ground forces were on duty. On six of the eight fires the jumpers arrived prior to the ground forces and were primarily responsible for control of the fires. Competition was consistently keen between ground and aerial personnel.

At the conclusion of the project results were analyzed and Region 3 believes they can justify an even larger parachute force next season for a longer period. The Region is sure a 12-man group of jumpers based at Deming and used over a 150-mile radius for a period of 2 months will more than pay its way in reduced damage and other fire costs.

One of the interesting portions of the project was the narrative report made by the jumpers on their return to base. The following report covering a single jump and fire was made by Emil M. Reidys, a boy who likes to jump and who comes from Flagstaff, Ariz. It may be of interest to readers of Fire Control Notes.

"Rocky Canyon fire—June 15, 1947.

"Preparations were made for a routine patrol; take-off time was about 9:40. After flying along uneventfully for a short while, a wisp of smoke was spotted—the aircraft circled the area. After our pilot had determined exact location by wireless and oriented the area, the decision was made to jump. In order to determine wind-drift, a drift-chute was dropped—as is invariably the case in all these operations. I left the ship at 10:40—exit and opening shock, normal. Rate of descent increased as I neared the ground—violent oscillation set in and a sudden down-draft had me in its grasp. The ominous crunching of wood and breath catching sound of rending nylon blended into one as my 'chute caught and held in the top of the tree. The canopy collapsed, the tree broke, and I obeyed the law of gravity—fell 20 feet and landed on point of left heel. The fire packs were dropped just above me on the ridge—my partner joined me and retrieved the tools—the wind favored us. After working 3 hours on the fire my foot gave out on me. The first smokechaser arrived on the scene about 2:40 and assisted on the fire. Baurer, my partner, set up the wireless and contacted Mimbres Ranger Station. Thereafter contact was maintained every hour on the hour till 6 p. m. The fire was under control at 3 p. m. The packer arrived around 5 p. m. Preparations were made to evacuate. We left the scene of the fire at 6:45 p. m. Two men were left to mop up. We arrived at the Mimbres Ranger Station about 6:30 a. m., Monday morning.

"Aside from inconvenience to other members of the group, due to my slight injury, everything went smoothly. After checking with the doctor at Silver City, we checked in to Deming Air Base at approximately 4:40 p. m., Monday, June 16."

(Signed) EMIL M. REIDYS,
June 24, 1947.

Comment.—"Outstanding above all else is the time element involved in all airborne operations. The sequence of events that follow after a jumper leaves the aircraft is, with a few exceptions, standard operating procedure. From a personal viewpoint of all men involved, it is a job one has to like in order to execute the assignment."

THE USE OF A WETTING AGENT ON A FOREST FIRE

EDWARD RITTER

Region 7, U. S. Forest Service

Comprehensive tests of wetting agents are planned. In the meantime experience of field men in trials like this are valuable and can speed up the full utilization of advantages that detergents may contribute.

Through the cooperation of State Forester Jacobson and Ranger Edson of the Rhode Island Forest Service, some interesting information was gathered on the use of a wetting agent in the control and mop-up of a spring fire.

On April 11, 1947, an accidental fire started at 12:20 p. m. on Division Street in the town of West Greenwich, central Rhode Island. It was picked up by the Pine Tower at 12:28 p. m. and a crew immediately dispatched, the first men and equipment arriving at 12:50 p. m. The wind was very strong at the scene of fire although the nearest fire weather station some 15 miles away indicated only a class 3 day. A strong southwest wind was recorded by the United States Weather Bureau station at the Hillsgrove Airport about 10 miles south of fire. Velocities at 10 a. m., 12 noon, 2 p. m., and 4 p. m. were recorded as 26, 27, 31, and 25 miles per hour respectively, with gusts recorded as 35, 37, 42, and 32 miles per hour.

The fire originated in a grassy field and blew across a 24-foot black top road into a slash area which had been cut over during the winter of 1945-46, the remaining stand consisting mainly of small scrub oak, pitch and white pine with a heavy accumulation of brush on the ground. The fire crowned heavily in the remaining trees but dropped to the ground and burned into stumps, duff, and brush piles.

The head of fire was controlled with backfire while the west flank was knocked down with water along the edge of a county road. In order to save time, additional cost, and burned area, it was decided to flank the east side without aid of a fire line, rather than to drop back to an old woods road and burn out, which would have increased the burned area by a third.

Twelve hundred feet of fire edge was completely extinguished by approximately 400 of the 600 gallons of water with a 1 percent solution of wetting agent carried in a fire truck with booster pump. The fire was burning in medium to heavy pine slash, some windrowed and some in piles. Many stumps were on fire. No brushing out was done.

Two hundred gallons of "wet water" from the aforementioned fire truck was used in 20 back-pack pumps in extinguishing the 50 or more spot fires which occurred. A second fire truck with a load of 450 gallons of "wet water" was used in mopping up for a width of 250 feet along the entire 1,200 feet of fire edge plus an additional stretch of 1,500 feet at the head and other sectors needing attention.

The ranger was not convinced that the fire was safe or out after the corral and mop-up had been completed 6 hours later so he left a patrolman for an additional 4 hours. No evidence of a holdover fire was noted later where the wetting agent had been used.

There is little point in attempting to show a saving in cost of suppression because of the many variables involved although it is believed a considerable saving in mop-up time might be apparent if figures were analyzed. It does suggest certain possibilities in control without the use of a raked, dug, or plowed fire line. Where the local practice by State or town warden crews does not emphasize line-building in control or mop-up, the use of a wetting agent should be most helpful in keeping burned area to a minimum. Incidentally, the fire described reached a size of 35 acres. Three wardens and thirty-two crewmen were used on the fire in addition to the two fire trucks. Total cost of fire was $137.30. Damage was estimated at $10 per acre or a total of $350.

On April 30, 1947, the effect of a wetting agent in the conservation of water on short lengths of unlined linen hose was demonstrated. By attempting to pump untreated water through 200 feet of dry hose at approximately 100 pounds pressure per square inch, it was found that the loss was so great due to leakage that the 40 gallons used failed to reach the nozzle, while the same quantity of water with a 1 percent solution of a wetting agent reached the nozzle end and 15 gallons came through with considerable force. No predictions will be wagered as to results with use of more water and longer lines of hose, greater pressures, etc. It is interesting to note, however, that there was no apparent difference in loss of liquids in a similar test with the use of mildew-treated forestry linen hose.

Modifying the Trapper Nelson Pack Board.—The following suggestion for modifying the Trapper Nelson pack board may be of some value to those who find frequent occasion to use it. Although I find it more comfortable for heavy loads than any other I have tried, including the Army frame pack, it has one serious drawback. It is poorly suited to use off trails, or on narrow, poorly cleared trails through heavy brush or undergrowth. The upper and lower ends of the frame supports catch constantly in the brush, throwing the wearer off balance, causing an excessive waste of energy, and materially slowing down progress.

By sawing off the upper and lower ends of the supports flush with the pack bag and by shortening the metal pack pins correspondingly, the above inconveniences should practically be eliminated. The loss of the extra lengths on which to hang rope or other odd items will, I believe, be more than offset by the advantages wherever any considerable amount of back-packing has to be done through heavy brush. Bernard Frank, *Washington Office, U. S. Forest Service.*

PLYWOOD WATER TANK

H. C. Buckingham

State Forester, Maryland

During the War when many kinds of metal were difficult to obtain because of the needs of the armed forces, forestry services were hard pressed for suitable water tanks to be used on forest fire patrol trucks. Many fire control agencies use ½- or ¾-ton pick-up trucks as the first striking units in forest-fire fighting. One such truck used by the State of Maryland is equipped with a fan-belt rotary-type pump, a 75-gallon water tank, 300 feet of ¾-inch rubber garden hose, a supply of hand tools for 6 to 10 men, and two-way FM radio.

Since corrosion-resistant metal was not obtainable, Maryland experimented with 50-gallon steel drums, cut-down fuel oil drums, and so forth. Finally at the suggestion of Senior Forest Supervisor Paul H. Seward, a waterproof plywood tank was constructed. This pilot model met the needs—rust free, watertight, shakeproof, easily installed, easy to construct, and economical.

The standard tank adopted is 47 inches long (the width of the pick-up body), 26 inches high (the distance from the floor to the bottom of the rear glass), and 19 inches wide. The reason for the narrow width is to permit the installation of a tool box behind the tank long enough to accommodate a standard fire rake. The ends, top, and bottom of the tank are of 1-inch waterproof plywood and the sides of ¾-inch waterproof plywood. One baffle was installed to prevent bulging and to reduce shifting of the load. The plywood was fastened to a 1½-inch frame of white oak with marine glue and galvanized screws set about 2 inches apart. In assembling the tank the top was put on last. This was to permit wiping excess glue, which would clog the pump, from all inside joints.

A 2-inch flange was used as an inlet in the center of the top of the tank. A 1-inch flange was placed on one end and a hole drilled through the pick-up body to permit a 1-inch pipe connection to a three-way cock installed on the side from which hose lines were taken to the pump.

The materials costs between $20 and $22. Two men can build a tank a day. Regular forest guards are assigned this work on wet days. An 18-gage stainless-steel tank of the same outside dimensions holds approximately 100 gallons or about a third more. It costs, however, about $92, or more than four times the cost of a plywood tank, disregarding contributed time of guards.

So far no tank has been discarded because of structural failures—none has warped, twisted, or opened at the seams. Once on the way to a fire, a truck upset and the tank, half full of water, was tossed several feet. After the truck was righted, the tank was replaced and used on the fire. No leakage resulted.

The only drawbacks to this tank are the volume of space used by the plywood and frame, and the fact that eventually the tanks become waterlogged and gain considerable weight. Experiments with thinner plywood to reduce weight and increase capacity are now being made.

SLASH DISPOSAL IN SELECTIVE CUT PONDEROSA PINE STANDS

Merle S. Lowden

Forest Supervisor, Fremont National Forest, U. S. Forest Service

Slash disposal is big business. As millions of acres of timberland are cut over in this country each year foresters, loggers, lumbermen, land owners and others are concerned that the hazard created in logging receives proper attention. An important requirement in changing virgin stands to managed forests is to keep protection costs in the cut-overs at a low figure. Costs of protection should be as low as is reasonably possible if forestry is to be profitable. The amount and type of hazard reduction done after cutting has a vital effect on these protection costs. There will likely always be two schools of thought as to the amount of effort that should be put into hazard reduction and that which should be devoted to extra protection. The ramifications of that argument are many. Regardless of the good points put forward by the "extra-protectionists" there still seems to be a place in protection for disposal of some slash. The insurance against large fires which prepared fire-breaks give cannot be completely depreciated.

Much of the cutting in ponderosa pine stands is now by tree selection with 30 to 70 percent of the stand volume removed. Adequate treatment of the slash hazard in this cutting presents many problems in both technology and economics. Study and experimentation in new and different methods may bring dividends far above their cost.

In carrying out a $60,000 annual business in hazard reduction on the Fremont National Forest during recent years our men have tried to devise new methods, practice economies, improve practices and in every way get the most in future protection from every dollar spent. Many of our ideas are not new. We've copied or adapted devices of others that looked good to us. Many foresters on other Federal, State, or private protection units likely have developed methods in advance of ours or at least ones they strongly advocate. Because we have had a large job of a particular type it seemed that our methods might be of interest to others.

Our aim in slash piling has been to establish prepared firebreaks along roads or otherwise at not too widely spaced intervals from which to backfire. In doing this we pile about 10 percent of the total cutover area. We don't expect to prevent fires by piling and burning slash but we do hope to reduce the burned acreage.

Planning the Job

We consider careful planning to be most important in all hazard reduction work. Planning means a visualization of the desired product and then setting up step by step procedures to get this product. Planning starts with a good base map of the forest area to be cut.

Our maps for "rushed" wartime cutting were not as good as we wanted. Logging plans are easier to make with a good map. A good base becomes the foundation for road plans, cutting progress maps, hazard plans, and future detailed fire control maps.

From the logging plan on a good base map an appraisal of the hazard reduction job can be made. This is necessary in most of our national forest timber sales where an advance cooperative deposit is taken to cover slash disposal. Such deposits have varied from 25 to 40 cents per 1,000 board feet of timber cut. The exact amount is based on an appraisal of the work needed.

Our hazard reduction plans are of two types: the over-all plan for a unit and the detailed plan for an individual project. An over-all plan may be for a unit as large as one or several townships. Project plans are usually for the work one crew will do in a season or a contractor will do in a reasonable time of possibly 1 to 3 months. The over-all plan consists of a map showing all roads and firebreaks on which slash is to be piled with such explanatory material as necessary to make the map clear. The plan outlines whether contractors or hired crews are to do the work, whether machine or hand methods are to be used and when the work is to be done.

Project plans consist of a plan map, narrative instructions covering specifications of the job, who is to do the work, when it is to be done, and a financial plan or budget. A short statement covers the extra protection planned for the area until the hazard is appreciably reduced.

Early in planning it is necessary to determine who will do the slash job, the operator or the Forest Service. Several years ago this work was usually assigned to the operator by the terms of his contract. We have gradually quit this practice. Now practically all our slash is covered by cooperative deposits and the work is done by our crews or is contracted. Where the operator did the work it was necessary to write careful specifications for the job. The work required close supervision and there was likelihood of misunderstanding. There are many advantages to the cooperative deposit method such as flexibility of funds, assurance of getting the exact type of work desired, having available labor to do other project work which is not of sufficient amount to support a crew, and the value of supplying off-season work for protection personnel.

Road construction slash is a particularly perplexing problem. Our former practice was to have the operator care for such slash. This did not always prove satisfactory. There is a likelihood of misunderstanding when the logging operator handles the construction slash and the Forest Service handles the logging slash. If road clearing is done well in advance of grading as should be done, the operator can pile the road debris without interfering with later work on logging slash. There are strong arguments for requiring logging operators to do this and if it is their responsibility unnecessary "pushover" tree messes are not likely to occur.

Snag Felling

An important part of the hazard reduction job is felling snags along roads, in other critical locations, and on firebreak strips. Snags not only are bad to scatter fire and hasten its spread but if not felled are

there to come down later and block roads. Location of the snags to be felled is an important part of the hazard plan. Our practice has been to fell all snags that would reach or that are within 100 feet of roads or bulldozed firelines to be piled. In addition, critical snags along ridge tops, around recreation or other public-used areas are felled. Practice has varied on different cutting areas as to whether we or the operator did the felling. Through the period of employment shortages in the war years the usual practice has been operator felling. They had trained fallers on the job and could get the required work done. Performance bonds assured that the required snags would be felled.

Many methods of snag felling have been used with varied success. As in felling green timber there doesn't appear to be a great saving in costs of machine felling over the hand method but it does take less men. Burning down is quite successful for many snags, particularly those referred to as "buckskins" and any with large cracks or pitch bleeding. Machine pushing works well in light soils, particularly those of the pumice type in the north end of our forest. Our largest operator there has pushed over snags along hundreds of miles of road during the last few years. There is need for more study on comparative costs for the various methods of snag felling. Present figures point to pushing on light soils, burning those that burn easily on heavy soils, and machine felling the balance. Burning with "goop" offers good possibilities and so far is working out well. It is being given a thorough trial to determine the best methods of use.

Managing the Slash Job

Each of our district rangers is directly in charge of the disposal job on his district. He prepares the work plans and financial budgets. These are approved by the forest supervisor and then placed in execution by the ranger. If it is a contract job, he has charge of preparing bid maps, staking the area in the field, and inspecting the contractor's work. On one district where the job is particularly large a project foreman supervises slash disposal work under the general supervision of the ranger. Timber sales personnel may assist in some details but we have found it best not to interrupt their primary timber work. Financial control is maintained through a project budget prepared by the ranger and approved by the supervisor. This sets up an allowance of man-days, mileage, supplies, and other predetermined expenses. Record of the progress of work is maintained by the foreman on his plan map and by the ranger for all projects on a district map. For a large unit on which several contractors are working, a map is prepared showing each contract in a different color. Progress is kept by putting a wavy line over the planned work line.

Slash Piling Methods

Methods of slash piling have changed greatly on this forest in recent years. The work was formerly done entirely by hand with hired crews. As wartime employment problems increased and the quality of available help decreased, contracting by the acre was encouraged. The bulk of our work is now done in this manner. Detailed specifications for piling are included in the bid requirements.

Hand piling has followed conventional methods except we have tried to take advantage of existing logs, uprooted snags and slash concentrations and to pile on them. Supervision of employed crews and close inspection of contractors is important. The real test of whether piling is good or bad comes when the piles are burned. Loose piles wet through quickly and after heavy rains or snowfall are hard to burn. Roughly a pile that can be seen through is too loose. We have tried to get the piling and burning done by the same persons but that has proven difficult. Contract pilers are often itinerants or at least want their money soon. They can't wait for it until the burning season. Sometimes we have been able to hire them later for burning work and usually it means better future piling. After a man has tried to burn wet loose slash he makes better piles. Hired crews have been mainly students and they are gone when the burning season arrives. The period when successful swamper burning can be done is short.

D–4 tractor equipped with slash-piling teeth on bulldozer blade. Note heavy shoe under blade which prevents teeth from digging in ground. Designed by private contractor working on Forest Service contracts.

In 1944 considerable experimenting was done with machine piling and this work readily sold itself. Different tractors were fitted with a variety of special teeth on the dozer blade until what seemed to be the correct set-up was worked out. Employment of operators at Government pay for this job proved difficult so other means were tried out. A local tractor owner was persuaded to equip his D–4 Caterpillar with the special teeth and try a contract. He did one contract and was anxious for more. This procedure is now well established and we have been very gratified with results.

Machine piling in general does many things in a better way than hand piling. It gets all the heavy fuels such as logs, large limbs, and uprooted stumps into the piles to be burned. Piles are larger and can be put in openings. There should be less damage in burning. With a little care on the part of an experienced operator there need be but

little damage to reproduction or valuable browse plants. Our machine-made piles have burned well. At the same time it has proven to be a cheaper method per acre. For 1945 and 1946 machine piling has cost us from \$9.50 to \$10.50 per acre with an average of \$10.20. Hand piling in the same period has varied from \$8 to \$14 per acre with an average of \$11.11. These are contract figures. Machine piling with our own operators has run a little less and hand piling with crews a little more than by contracting. Contracting takes less overhead and is a means of accomplishing a job when hired help cannot be obtained. We hope to get more private owners to equip their bulldozers for piling slash and thus get more competition and more available equipment. Machine piling has the added advantage of providing a very good suppression tool where it is likely to be needed during the fire season. After watching the work of various sizes of bulldozers from a small Clarkair to a large D–8 we favor a medium size.

D–4 tractor equipped with slash-piling teeth on bulldozer. Note heavy material being placed in pile.

In our piling along roads or skid trails we usually work 100 feet on each side after the snags have been felled. A set distance aids inspection of contract work and requires less supervision. With our own crews we often vary the strip width to meet hazard and need conditions. Our chief problems beside loose piles are those that are too small or those piled too close to live trees.

The Burning Job

Our burning methods have varied as widely as have our piling procedures. We have tried many types of torches or burning machines, impregnated sawdust and planer shavings, goop, flame throwers and old fashioned methods of kindling. Dryness of slash and weather conditions determine the best device for a particular job. It is difficult to get ideal conditions between the time fire will not spread from burned piles until the piles are too wet or the snow too deep. This time

is usually short. When the slash is fairly dry we have found a good hand flame torch utilizing air pressure or the drip torch to be the best. Several types are suitable. Sawdust or planer shavings soaked with a mixture of one-half gasoline and one-half Diesel oil is good on tight piles even though wet by rain or covered with up to 4 inches of snow. We mix the materials in open barrels, pack in buckets and distribute with scoops made from tin cans. This method is better than hand torches on fairly wet material but slower than the torches on drier slash. Goop seems to work best on very wet material or heavy chunk and logs. It is slower than the other two but has a real place when used liberally on large piles, logs, whole trees or any wet material. We've tried several "machine" burners but haven't yet found a fully successful one. With improvements or perhaps other types we have not used they undoubtedly have a real place in slash burning.

Immobility, initial cost, fuel cost, and mechanical faults have been the chief drawbacks to those we have used. With further development they will likely gain in favor. There is a large field for experimentation with a cheap, easily used chemical burner on the order of a fusee but more powerful and longer burning.

We have a burning plan for each district and try to hit the job hard when conditions are right. Fortune smiled on us in 1946 and we got nearly 100 percent of our piling burned. On one district the crews burned 87 miles piled on both sides of roads or plowed lanes in 1945 and 59 miles in 1946.

Other Measures

Following logging we try to get all roads signed as soon as possible. Many of our large areas are a maze of roads which would baffle a taxicab driver. We name main roads and sign them with termini and distances. On other roads we use a numbering system from 1 to 100 or more. Units distinctively separated have a different series of numbers starting at one. Every road junction or takeoff is signed. Road numbers are shown on the detailed fire maps. These maps cover all cut-overs and when completed will cover the entire forest. We have a key map for the forest showing the units covered or to be covered with detailed maps. Besides showing all roads with their name or number the maps show physical features of value as fire control information and the location of prepared firebreaks. Lookouts, firemen, or other personnel working in or near a unit have the map for it.

In planning protection of cut-overs there are of course many other aids that must be considered such as water developments, personnel, equipment, detection, closures, patrols, prevention efforts, roads, and cooperation. But those are other stories.

INFORMATION FOR CONTRIBUTORS

It is requested that all contributions be submitted in duplicate, typed double space, and with no paragraphs breaking over to the next page.

The title of the article should be typed in capitals at the top of the first page, and immediately underneath it should appear the author's name, position, and unit.

Any introductory or explanatory information should not be included in the body of the article, but should be stated in the letter of transmittal.

Illustrations, whether drawings or photographs, should have clear detail and tell a story. Only glossy prints are acceptable. Legends for illustrations should be typed on a strip of paper attached to illustrations with rubber cement. All diagrams should be drawn with the type page proportions in mind, and lettered so as to permit reduction. In mailing, illustrations should be placed between cardboards held together with rubber bands. *Paper clips should never be used.*

When Forest Service photographs are submitted, the negative number should be indicated with the legend to aid in later identification of the illustration. When pictures do not carry Forest Service numbers, the source of the picture should be given, so that the negative may be located if it is desired. Do not submit copyrighted pictures, or photographs from commercial photographers on which a credit line is required.

India ink line drawings will reproduce properly, but no prints (black-line prints or blueprints) will give clear reproduction. Please therefore submit well-drawn tracings instead of prints.

The approximate position that illustrations bear to the printed text should be indicated in the manuscript. This position is usually following the first reference to the illustration.